THE ENGINEER

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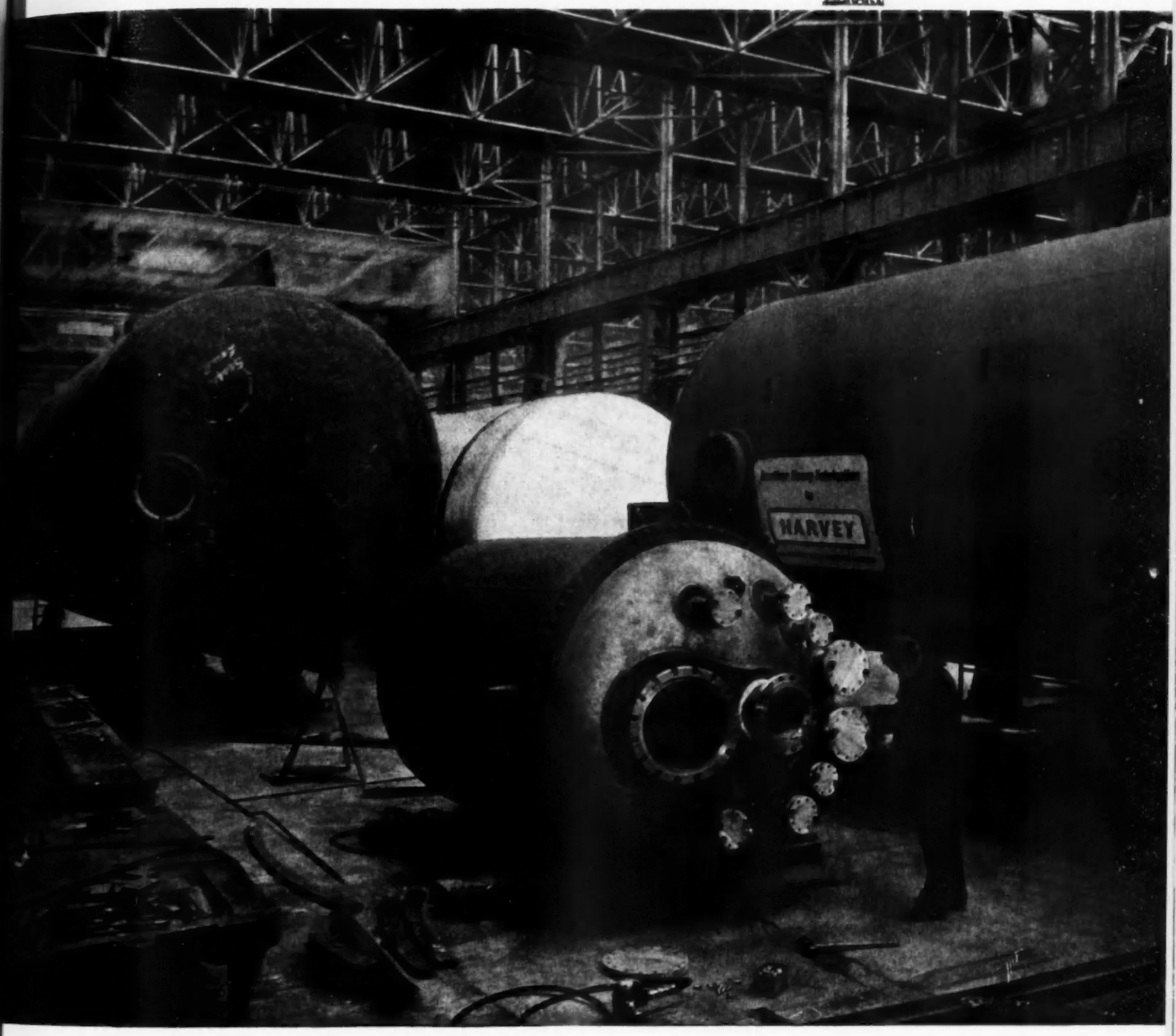

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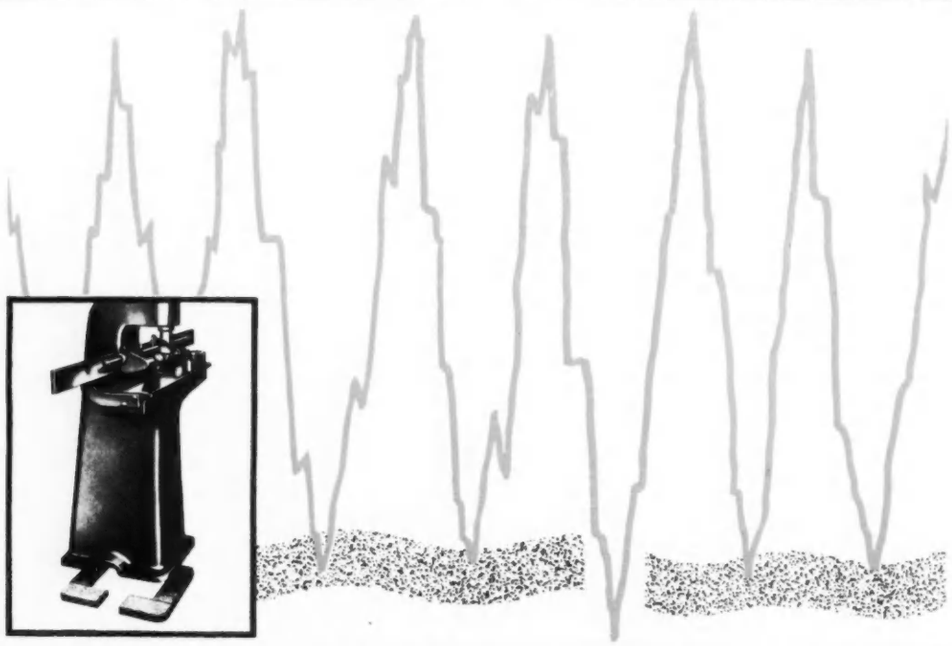

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THE ENGINEER

Established 1856

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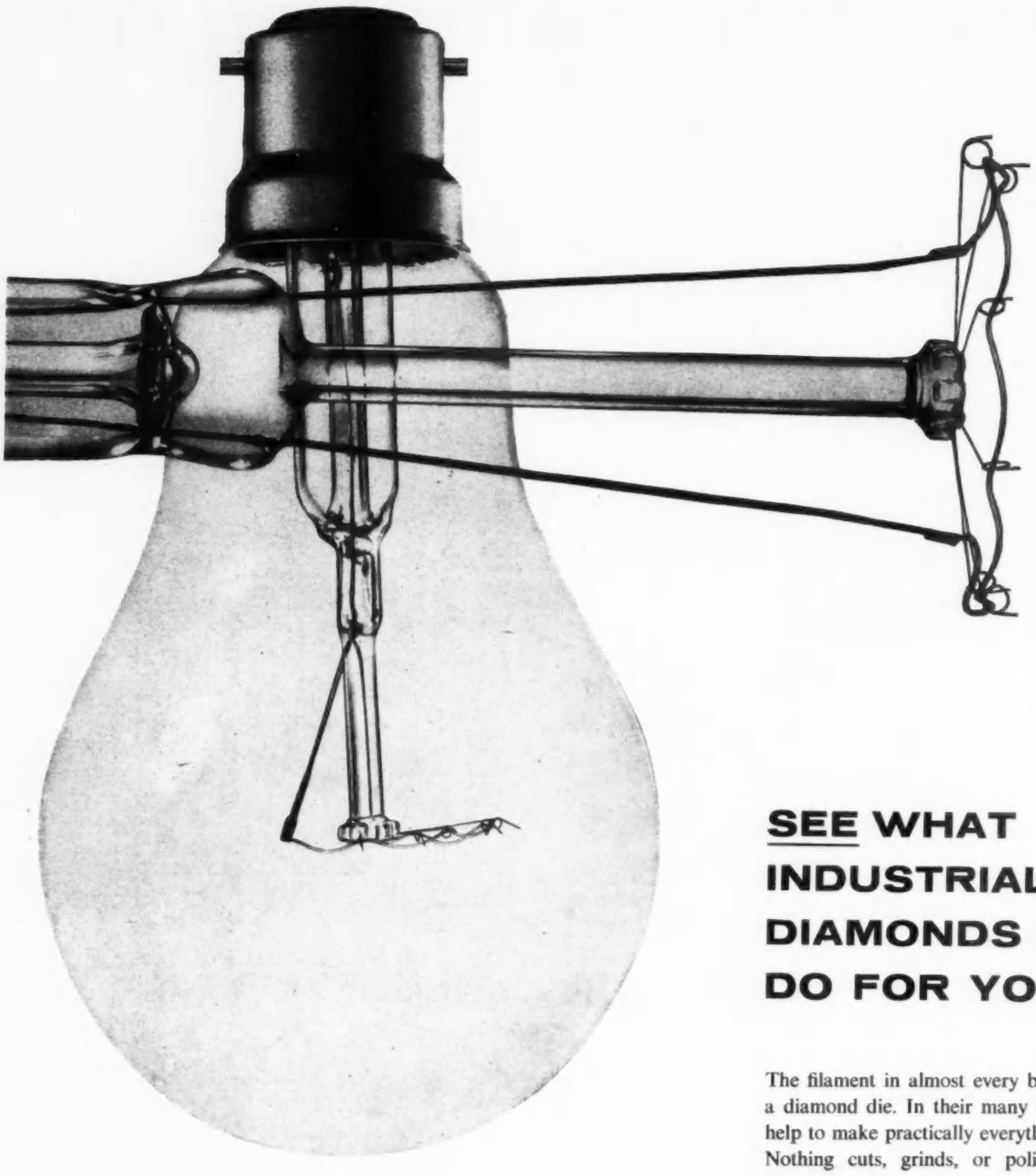

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THE ENGINEER

No. 5485 MARCH 10, 1961 Vol. 211

TAPS ON TRIAL

There was recently published to all and sundry a report by the Production Engineering Research Association on the "Performance of Taps." Though members of that Association have been aware of the findings for some years it will be with astonishment that those who have not had the opportunity to see it before, will read the Report. It is a reasonable supposition, for example, that, though different manufacturers may well have differing ideas about the design of taps, the taps made by each should be consistent in material, shape and performance. They are not! Or rather they were not at the time the laboratory conducted its studies. It may well be that some, at least, of the manufacturers have changed their production methods since the Report was first issued to members some five years ago. The object of PERA was to determine the geometric shape and performance, when tapping low carbon steel, of fourteen makes of 2 B.A. and ½in B.S.F. straight flute, ground thread taps. To quote from the Report, "There were marked differences in the shape and performance . . . of taps of the same make and different makes." The tolerances to which the taps were made were, it seems, much wider than those specified in B.S. 949:1941. Where the relevant British Standard had no recommendation to offer the confusion was found to be even worse confounded as not only did some makers clearly manufacture to tight tolerances and others to slack ones but no one manufacturer seemed to agree with another where tolerances should be tight or slack or what the mean value of certain dimensions should be! Those remarks apply particularly to the chamfer angle at the outer end of a tap, the flank width, chamfer relief, body relief, rake, and flute area. But differences were not only dimensional. The mean hardness of the material used for the taps ranged from 749 to 962 D.P.N. (30 kg load) and though all the taps were specified and supplied as 18-4-1 high speed steel there were significant differences in composition. In these circumstances it is not surprising that marked differences in the performances of the taps were discovered. Those differences seemed almost as likely to occur amongst the products of a single maker as between the products of different makers! Three ½in B.S.F. taps by one maker, for example, tapped before failure 1125, 1297 and only 288 holes. The range in performance proved quite astonishing. Less than a quarter of the taps tested succeeded in tapping satisfactorily 3000 holes. Over half failed to tap satisfactorily 500 holes; a quarter never got into treble figures!

One of the conclusions to be drawn must surely be that up to the time when PERA put the work in hand no one had ever set out to establish what are the preferable dimensions and correct metallic condition for a tap. From the tests reported workers at PERA were unable to determine at all clearly what features can be classified as good, bad or indifferent. Though the variations in performance were "comparable with the range of variations in the values of the geometrical features measured" it was not possible to relate differences in tap performance with any particular feature of a tap. An observation "considered to be important" was that for sixty-six of the taps tested "failure was associated with the production of oversize holes which may have been caused by build-up on the tap flanks." It was also thought that "the metallurgical properties of the tap and surface condition of the ground thread have a marked effect on tap performance."

Workers in the laboratory went on to investigate the effects of rake and flute area on tap life, using taps "ground accurately and consistently to selected values" in the laboratory. The recorded lives of these taps showed substantial scatter, but incomparably less than that of the taps as supplied by manufacturers. Except for some whose flute area turned out (as was indeed expected) far too small, all succeeded in tapping at least 1000 holes and the best (3 per cent rake and 60 per cent flute area) tapped no less than 14,100 holes. Most of these taps failed due to wear on the threads, not by build-up. A conclusion reached was that the effect of rake on tap life is not marked; taps with rakes from 0 deg. to 15 deg. yielded satisfactory lives. But there were indications that a rake of 3 deg. might have a slight advantage. The effect of flute area was also found not to be marked, so long as a minimum was exceeded. A minimum of 40 per cent of the area within the major diameter was suggested, partly on the ground that room will thus be left for regrinding of the tap. "Since the tap strength is reduced as the flute area is increased provision of flute areas of more than 60 per cent would considerably increase the risk of tap breakage."

Again and again in contemplating the work carried out by research laboratories we find ourselves astonished by their need to carry out investigations which we would have expected to have been done long, long ago by individual firms. Here is just one more example. The work on the subject at PERA has continued. We suspect — and certainly hope — the issue of the Report to PERA members will have led a number of firms (users as well as makers, no doubt) to make their own tests; and that substantial improvement in the performance of taps has followed.

AIR-COOLED DIESEL ENGINES

On January 19, 1961, a copiously illustrated symposium dealing with the evolution and trend of development of air-cooled diesel engines was presented at a meeting of the Diesel Engineers and Users Association. The three papers making up this admirable symposium were contributed by engineers closely connected with the current development and manufacture of engines of the type dealt with. Paper No. 1 ("Engines of Low Weight and Power and High Speed") was submitted by Mr. John Smith, M.I.Mech.E., technical director of Petters, Ltd. The author of Paper No. 2 ("Air-Cooled Engines for

Traction") was Herr W. Lüderitz, research and development engineer, Klöckner-Humboldt-Deutz A.G. The third paper ("The Evolution and Trend of Development of Air-Cooled Engines of High Power") was by Mr. M. F. Clover, M.A., development engineer, Davey Paxman and Co., Ltd. All three papers are rendered the more interesting through being stamped not only with frankness and clarity, but with a strictly technical appraisal of the subjects dealt with.

It is remarked by Mr. Smith that caution can be due to lack of experience and he shows, by specific examples, how ten years' experience preceded the introduction, about 1957, of an air-cooled diesel engine rated for 10 b.h.p., with a weight of 330 lb. and a speed of 3000 r.p.m. In the earlier engine of the same power the speed was 1500 r.p.m. and the weight 550 lb. After detailing the advantages claimed, at the outset, for the air-cooled industrial engine, Mr. Smith sets forth his comments as to "whether the advantages claimed can be substantiated and whether there are any disadvantages, which have arisen in service, to counteract the advantages." What he has to say on this highly practical aspect will be examined with interest by all users or potential users of small diesel engines. It may surprise many users to read that "cylinder wear rates of 0·002in. per 1000 hours have been recorded on 3000 r.p.m. engines, with cast-iron unhardened cylinders" and that "such low rates are typical of air-cooled engines in relatively clean atmospheres." The quicker warming up of the air-cooled engine is favourable to cylinder life and it has long been known that with water-cooled engines there is or should be a very definite relationship between liner wear and the number of cold starts. This, it would seem, is something not without considerable significance in relation to agricultural and mobile plant where the number of cold starts is likely to be relatively high. In commenting on future trends, Mr. Smith foresees that "There will . . . be many problems to solve before really small engines of say 6000 r.p.m. are reliable power units and not many of these problems will be resolved on the design board. Rather is it a question of applying existing design knowledge to the accurate manufacture of small components, and the development of new systems "not so sensitive to accuracy of manufacture."

The second paper in the symposium (by Herr W. Lüderitz) has special reference to design problems associated with the air-cooling of diesel engines; the application of air-cooled engines to traction; and the growth of production and usage of air-cooled engines in Germany. He opens by reminding us that even in liquid-cooled automotive engines air is the actual coolant "the liquid being the mediant to transfer the heat from the engine to the radiator or heat-exchanger." We are not surprised to note how Herr Lüderitz mentions that while high-speed air-cooled engines of the highest performance (used primarily for military purposes and correspondingly expensive) have operated with b.m.e.p. as high as 170 lb. per square inch., "the resultant peak pressure of more than 1400 lb. per square inch at a supercharging pressure ratio of 1/2.5 raises the mechanical stresses in the cylinder-head close to safe limits. Accordingly, still higher supercharging to produce b.m.e.p. above 200 lb per square inch at continuous operation is for liquid-cooled engines with strong unit-bloc structure." Among other pertinent comments Herr Lüderitz deals with the matter of noise. While he finds the water-cooled engine quieter than its air-cooled competitor, "careful research work has made it possible to considerably reduce the noise of the air-cooled engine. . . . Automobiles equipped with modern air-cooled engines and well insulated, such as the new Chevrolet "Corvair" and the Deutz-Magirus bus operate at a noise level equal to any water-cooled vehicle." On the cylinder size of air-cooled engines he remarks that "the maximum cylinder size is limited primarily by the thermal problems increasing with the bore, which does not exceed approximately 6·3in. Beyond this size the cylinder-head gasket becomes a problem because the mechanical stresses in the head liner connection are difficult to control and water cooling is preferable, the more so since also the fin surface area available is no longer sufficient for air cooling, thus leaving the field of still larger units to the water-cooled engine."

In the third paper Mr. Clover relates how, currently, the largest Paxman air-cooled "V" type "Vega" engine has twelve cylinders 6in bore by 6·6in stroke and gives 400 b.h.p. at 1800 r.p.m. continuous rating (79 lb per square inch, b.m.e.p.). Dwelling on the question of size, the limit, according to Mr. Clover, "has by no means been reached and air-cooled engines of up to 7in bore are probably possible. The introduction of larger engines and of high-pressure turbo-chargers will almost certainly mean the use of oil-cooled pistons, and this in turn will make it impracticable to house the necessary oil cooler in line with the cylinders." In reference to the modest engine rating of the air-cooled "Vega", Mr. Clover points out that "some power is accounted for by the fan, 27 h.p. on the twelve-cylinder engine, equivalent to 5 lb. per square inch b.m.e.p." He further calls attention to "the additional heating of the intake air on the induction stroke compared with a water-cooled engine. The drop in volumetric efficiency in the multi-cylinder engine from 85 per cent at no load to 75 per cent at full load is twice what is expected in a water-cooled engine. The specific fuel consumption at full load at 1800 r.p.m. is 0·41 lb./b.h.p./hour, or 0·385 lb./b.h.p./hour, if the fan horsepower is included." On the question of noise, Mr. Clover, in remarking that the air-cooled engine tends to be noisier than the water-cooled engine of the same power, names the fan as being chiefly responsible. It can, he says, "give a most irritating high pitched whine, but fortunately this noise can be easily suppressed."

Study of this admirable symposium can hardly fail to show how there are applications wherein the advantages of the air-cooled engine outweigh its disadvantages. For engines working in the open especially in cold climates; farm tractors; excavators; road and building construction equipment; oil well drilling rigs; portable generating sets; or in situations where suitable cooling water is not available or its supply may be uncertain, engines which can be depended upon to operate satisfactorily without water cooling present manifest attractions.

HIGH VACUUM: A RAREFIED OCCASION

Last week for a period extending over two days the Institution of Mechanical Engineers held a Symposium on "User Experience in Large Scale Industrial Vacuum Plant." We confess that upon reading the list of titles of the papers to be presented we began to doubt whether the subject was really suited to treatment as a Symposium. Consider, for example, these four, one each from the four sessions into which the presentation of papers was divided, "Vacuum Annealing of Copper," "Applications of Electron Bombardment Heating in Metallurgy," "Vacuum Requirements for Research in Aerodynamics,"

and "The Use of Vacuum in the Preparation of Veterinary Products." The object of holding a Symposium, as against the reading of individual papers before ordinary meetings of a society, is that of bringing together people working in closely related fields so that there can develop a fruitful exchange of information. But is the fact that certain operations are carried out under differing degrees of vacuum a sufficiently strong link? In an Introductory Address Mr. McNeil, Chief Engineer of Unilever Ltd., remarked, "Processes required to operate under vacuum are many and varied" — the titles of the papers fully supported that view! — "and the quality of the vacuum will also vary widely. There must, however, be many aspects, within these variations, which are common in principle to all installations either in the process equipment itself or in the associated equipment for producing the vacuum. These common aspects are in part related to design, in part to methods of testing and also to the application of instrumentation and automatic controls." But he had also to remark at one point "In some cases the internal requirements of processing equipment are complex to the extent that the influence of low absolute pressures might appear to be of subsidiary importance." Our impression is that, regarding a Symposium as a means of encouraging fruitful cross-fertilisation, it was not fully a success. We had the impression — possibly mistaken — that there was a partial change of audience as each session closed and a new one opened. It will be no easier to judge, we suspect, even when the papers and their discussions are published in due course by the Institution. For much of the cross-fertilisation which occurs at a Symposium arises out of meetings away from the conference hall of men working in similar fields and encountering similar problems and the creation thereby of enduring links between men working in places so widely separated that they would never normally meet. To what extent were such links created at the Mechanicals last week? Only those, experienced in vacuum plant, who attended the Symposium, and especially those who attended all its sessions, can really express an opinion.

BUDGET REPRESENTATIONS

This, of course, is the time of year when a variety of bodies make representations to the Chancellor of the Exchequer. A fortnight ago, the Federation of British Industries and, almost simultaneously, the General Council of the Trades Union Congress published their representations. During the past week the British Road Federation published its Memorandum. Much the most interesting of the three is the T.U.C. document. For, apart from a representation that investment allowances "should not be switched on and off" — a point now widely accepted by economists — and the repetition of several detailed proposals for taxation reform which have been made before, the Federation's document is almost solely concerned to argue that surtax is too high, that it ought to be reduced, and that income tax and surtax should be merged into one graduated tax on personal incomes. That argument is based on the view, probably a very sound view, that surtax at present levels makes it "absurdly costly . . to offer rewards which will induce men of exceptional ability to undertake heavier work and responsibility." Not unexpectedly the T.U.C. General Council is unimpressed by arguments that surtax should be reduced. It finds it, instead, "disturbing that the Government's handling of Britain's economic affairs has failed to harness our great industrial potential to the task of increasing production and productivity, which would help to increase the balance of exports over imports." Its document draws attention to two objectives, "more investment to secure higher production and greater productivity and more exports" as those to which "the main emphasis of the 1961 Budget should be directed." It is understandable, also, in a document coming from a body particularly sensitive to any increase in unemployment, that it should call for a Budget "which will encourage the tendency to expansion which has showed itself." But unfortunately there is the usual hankering after controls (Whitehall knows best!). "It is our view that the Government must go beyond the stage of general or even specific exhortation and examine what more positive measures they can take to increase exports, even if this involves the limitation of home sales of some products." All the same it is surely true that "the adoption of policies aimed at breaking the cycle of limited expansion followed all too quickly by stagnation or recession would command wide support on both sides of industry and in the country as a whole." The trouble is that economists do not seem to be agreed what those policies are! As for the British Road Federation document it suggests, as might be expected, a reduction in the taxation of road vehicles and fuels. It points out how rapidly yields of road taxation have increased and how low is the proportion of the yield actually spent on roads. Almost every road vehicle owner will support the Federation. Alas! We fear it is likely this year that the Chancellor will take no more notice of this document than he has of similar documents issued each year for many past years!

The Engineer—100 Years Ago (MARCH 8, 1861)

"PORTABLE WORKSHOP FOR THE PACHA OF EGYPT"

"Messrs. R. Stephenson and Co. are about to send out a workshop on wheels, destined for the Pacha of Egypt. The workshop embraces a lathe, a drilling-press, a saw-mill, a portable furnace with fan blast, a steam hammer and a grindstone. The motive power is supplied to these by means of two double cylinder portable engines, of about 12-horse power each, which resemble in their general appearance and construction those attached to ploughing machines. The cylinders, however, which act in the same direction as in a locomotive, are placed on each side of the boilers, near the top, where they work two driving-wheels of about 3½ft. diameter. The engines, which are made to look in opposite directions, are attached to each other by means of a belt that revolves from the driving-wheel on the right of one engine to the driving-wheel on the left-hand side of the other. The remaining driving-wheels, which are opposite to each other when placed in position, are directly attached to the machinery. The various machines and engines are mounted upon carriages with broad wheels, and will be dragged by horses. The steam hammer is on an improved principle, invented by the firm, and can, by an ingenious contrivance, be made to adjust itself to the axle of its carriage, on which it revolves, and from which it can be detached at pleasure. The whole of the apparatus, together with a water tank to supply the boiler, and a timber carriage to convey the wooden rails on which the machinery stands, is painted white, with black linings, and has a light and symmetrical appearance."

Canadian Pacific Transcontinental Trains

THEIR MOTIVE POWER AND EQUIPMENT

By EDWARD H. LIVESAY

No. IV—(*Concluded from page* 328, *March* 3, 1961)

HAVING described as graphically as possible what one sees in the cab of a diesel-electric locomotive working over the mountain divisions of British Columbia, to me always the most fascinating part of the whole C.P.R. main line between Montreal and Vancouver, there is no need to go into it any further, as it would only be repetition ; the reader must do what I did, carry on in the train. But before we leave Calgary, I would like to touch briefly on the work of the Budd R.D.C. " Dayliners " running between that city and Edmonton, as over this 194-mile stretch they really have to show what they are capable of in the way of high speed associated with frequent stops, entailing quick acceleration and deceleration, the very points in which they excel, and a maximum of 80 m.p.h. ; it will be remembered that on the Esquimalt and Nanaimo Railway dealt with earlier in this article, the Budd car is limited to roughly half this speed. I had ridden the R.D.C. from Edmonton to Calgary a year or so before in order to compare its performance with that of the very fine 4–4–4 steam locomotive No. 3001, (Fig. 19) with its 6ft 8in wheels, hauling the streamlined " Chinook " over the same line during the war (THE ENGINEER, November 21, 1941) ; at that time both engine and train were the " last word " connoting high speed in the West. The comparison is illuminating ; both steam and diesel machines touched the same maximum, 80 m.p.h., frequently *en route*, and made about the same number of stops, but the " Chinook " took five hours as against the " Dayliner's " 3½ hours, and I have no doubt that both were doing their best. Here one sees the effect of rapid acceleration and deceleration, far beyond anything the " basic design " steam locomotive could achieve. The four trains running in each direction between Calgary and Edmonton have all been diesel operated for some time, though their make-up is equally divided between R.D.C. and regular trains hauled by diesel-electric locomotives ; all are considerably faster than when steam-powered.

No. 304 " Dayliner " left Edmonton at 8.40 a.m. for Calgary, on a typical Alberta " Indian Summer " day in early December ; the air was " nipping and eager," the sun just rising in a cloudless blue sky, making glitter a sprinkle of snow that reminded one winter was just round the corner. Acceleration was very rapid, altogether faster than that of the powerful 4–6–2 on which I had made the same run a couple of years before. After crossing high above the North Saskatchewan River and making the first stop at South Edmonton, 2·2 miles from the start, there followed a straight stretch of 18 miles to Leduc, along which 75 m.p.h. was hit and held most of the way. The riding was excellent, only the tilting of the floor giving evidence of curvature ; the suspension was very good, crossings and switches being imperceptible ; speed was deceptive, as it always is on a diesel until one gets used to things, being generally about 25 per cent higher than estimated. The braking, with shoes acting on air-cooled discs, was ultra-smooth and powerful ; no noisy juddering ending in jerky stops. For long distances the main road paralleled the track, which naturally induced racing on the part of cars travelling south, but it did not always result in favour of the road vehicles—a Budd car can reach 89 m.p.h., and not every type of motor vehicle can equal that even nowadays. Gradients were practically ignored unless lengthy ; the driver, or motorman—surely not "engineer"?—complained " She's not running like she ought—one unit is never as fast as two." On my suggesting that wind resistance probably accounted for this, he was inclined to agree—two cars (Fig. 21) have twice the power of one, but close-coupled, wind-resistance does not increase in the same proportion.

Leduc brought to mind Canada's potentialities as one of the world's major oil-producing countries ; it was here that a few years ago the first great gusher blew in, flooding the countryside before it could be got under control, starting the boom that transformed Alberta's financial position—or lack of it—metaphorically overnight. Since then, a large number of successful wells have been drilled, but we are not told how many dry holes were sunk—would ten to one be about the ratio ? However, the producing wells have paid for the duds many times over, and new fields have been located all over the northern part of the Province ; I believe many wells are capped, over-production being the factor taken into consideration.

There was considerable curvature approaching Red Deer, but it was taken admirably ; however, it cannot be altogether disregarded by a Budd R.D.C., owing to the water tank being on the roof, which results in consideration being given to the centre of gravity—I was told this on the Esquimalt and Nanaimo R.D.C., which certainly has plenty of curvature to negotiate. The speed was consistently high, but the driver continued to express dissatisfaction with it, saying we were behind time, and " She just isn't running fast enough to pick up any." It seemed quite good to me, but from my notes, studied after the trip, he was evidently right, as at Innisfail we were five minutes late—partly due to entering a siding at Niblee to allow passage of a steam-hauled train—one entry reading " speed never exceeded 80 m.p.h. even down-grade—car not running freely." Nearing Olds the Rockies came into view on the right, a jagged blue-white line against the sky ; the sprinkle of snow had disappeared, leaving the landscape a symphony in gold and black—stubble and summer-fallow, under a blue canopy, typical of Alberta in the fall or early winter—it only needed a warm Chinook wind to turn everything to mud underfoot. At Beddington there was an out-of-schedule stop, yet despite this and the previous persistent late running, all lost time was regained over the last few miles into Calgary, where we came to a stand three minutes early—according to my notes, but I doubt it—probably about " On Time," or the concluding stage of the trip must have been covered at meteoric speed of which I have no recollection. It had been a fast and interesting run, demonstrating how serviceable these one- or two-unit trains are when shuttling between such cities as Calgary and Edmonton, with several stops intervening. Steam power could never do what these railcars effect, and never did ; acceleration was poor, and there was too much dead weight. A few weeks before making the above run, I had ridden from Paris to Havre in the cab of an " Autorail " train—five cars to Rouen, and three thence to Havre—and comparison was timely, though the conditions were somewhat different. Maximum speeds were much the same, 80 m.p.h., but the " Autorail " was a real train, and made only three stops as against the R.D.C.'s eleven, so the former's average was somewhat higher, but its schedule less exacting. The log of the R.D.C. is given below.

		Miles	Schedule	Actual
Edmonton		—	8.40 a.m.	8.40 a.m.
S. Edmonton		2.2	8.48 a.m.	8.48 a.m.
Leduc		17.8	9.05 a.m.	9.07 a.m.
Wetaskiwin		22.0	9.26 a.m.	9.27½ a.m.
Ponoka		22.0	9.45 a.m.	9.48½ a.m.
Lacombe		17.0	10.01 a.m.	10.05½ a.m.
Red Deer	arr.	18.0	10.22 a.m.	10.24 a.m.
Red Deer	dep.	—	10.25 a.m.	10.27 a.m.
Niblee		Siding stop for passing train		10.45 a.m.
Innisfail		18.5	10.44 a.m.	10.49 a.m.
Olds		18.5	11.05 a.m.	11.08½ a.m.
Didsbury		10.00	11.16 a.m.	11.18 a.m.
Beddington		38.0	½ min. stop	—
Calgary		10.00	12.10 p.m.	12.07 p.m.
		194	210 min.	207 min
		Average 56·2 m.p.h.		

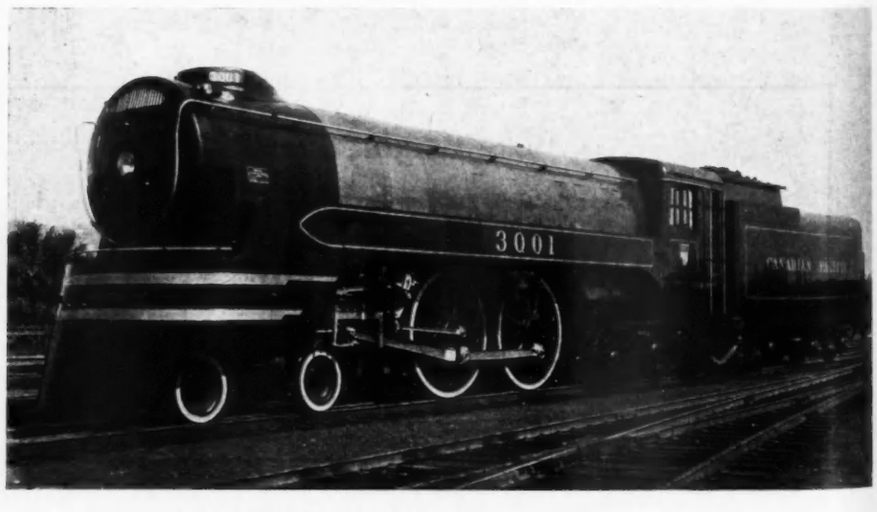


Fig. 19—4-4-4 " Jubilee " class express engine

The things that impressed me during this run are underlined in my notes—acceleration and deceleration—the rapidity of the former and the smoothness of the latter, plus the firm grip of the disc brakes—their perfect action, so much better than the crudity of the rim pattern. The company has supplied the following data of brake performance : 3·5 m.p.h. per second in emergency, and 2·8 m.p.h. in ordinary service. A fully loaded R.D.C. has been stopped in 2330ft from 85 m.p.h. with service braking ; in emergency a loaded R.D.C. can be stopped from 85 m.p.h. in 1900ft. It seems my suggestion to the driver on the effect of wind-resistance was correct, the data including the following : at 85 m.p.h. the resistance of each car behind the leading vehicle of a multiple-unit train is less than half that of the leader—evidently the result of reduced wind pressure. Continuing, it is stated that " improved performance " is associated with a multiple-unit train, to an extent that a three-car train can run on level track with direct drive at 65 m.p.h. on one-third throttle, and on 1 in 100 at 70 m.p.h. on full throttle. The advantage of having two engines is shown by the ability of a single car to run home at 62 m.p.h. on every night—and did so. No, I do not quite like the idea of no sleepers !

When in England last year, Mr. Thompson, chief motive power officer, British Transport Commission, posed several questions concerning diesel operation on the C.P.R., which at the time I was unable to answer, one being the distance the engines run without shop attention of any kind ; the answer that can be given now is that at any rate 2882 miles is done—Vancouver to Montreal or vice versa. The transcontinental passenger units are maintained at Montreal, making return runs thence to Vancouver, subject to the possibility of units being added to or taken off the trains *en route* for traffic or operational reasons ; for instance, one unit comes off the eastbound " Dominion " at Calgary as already mentioned, leaving two to carry on across the prairie. Presumably no major work is done at Vancouver, so in the ordinary course of events diesel units run 5764 miles before returning to their home shed to receive thorough examination or repair. On transcontinental passenger trains they are watered at each divisional point, which average 125 miles apart, and are refuelled at every third divisional point, roughly 400 miles. It least, and introducing other disabilities concerning the running staff. This brought confirmation from sundry railway officials, and from enginemen, who said they were sometimes trained on one particular make and then set to work on another with dissimilar controls, calling for some degree of re-education. In North America diesel motive-power has long been practically standardised, this applying not only to design but to controls, which are practically identical on all classes. A Canadian engineman finds himself at home on whatever sort of machine he has to handle, but I gather this is not always the case in Britain. In North America a " standard " design of diesel-electric locomotive was settled upon well over a decade ago, and has been adhered to ever since ; it has a comparatively slow-running, rugged motor, reliable and easily maintained ; all " teething troubles " have been eliminated years back, breakdowns are few and far between, the machines just run and run, and enginemen do not need to know much about them, or do anything to them *en route*. All of which as it should be ; I do not gather this is quite the case yet in Britain. After all, British manufacturers have had ten years or more to settle on

Fig. 20—Day coach with reclining chairs

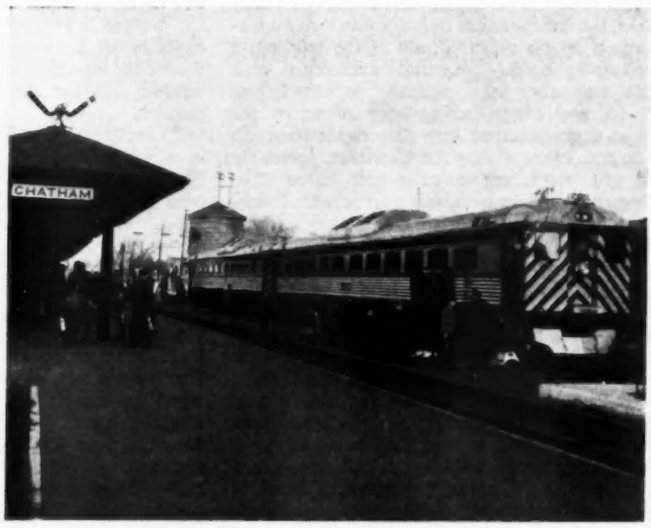


Fig. 21—" Dayliner " two-unit diesel railcar

direct drive and level track with full throttle, and at 50 m.p.h. with torque converter drive on two-thirds throttle. Fuel consumption is in the neighbourhood of 2½ miles per gallon, though it would be higher naturally if stops were closely spaced. As to brake shoes, it is stated the disc pattern needs renewal after 50,000 miles, as against rim shoes' 6000. So much for the railcars ; they are certainly very practical vehicles with a sure future.

After standing in Calgary forty minutes the " Dominion " left at a little after 10 p.m., and with three nights and two days in the train ahead, an observer can look forward to a peaceful time conning his notes and considering first impressions—I was travelling via Toronto, which should be reached at 7.20 a.m. three days later—Canada is a country of big distances. Further, additional material had already been supplied by courteous officials, and more was sure to come to hand *en route*. The contemplated withdrawal of sleeping accommodation from the " Dominion " and certain other trains, mentioned before, had not taken place on the occasion of the present journey, which was fortunate, as I was looking forward to making full use of my berth for twelve hours follows the " Dominion," after leaving Vancouver, was watered four times—at North Bend, Kamloops, Revelstoke and Field—in covering the 640 miles to Calgary, and was refuelled at Revelstoke, 379 miles from the start. At fuelling stations the equipment is given visual inspection by mechanical staffs, and at Vancouver an intermediate inspection is made.

During my pleasant chat with Mr. Thompson, he inquired how often the running-gear of Canadian diesel engines was pit-inspected, saying—if I remember rightly—that he hoped it would be possible to have British diesels put over a pit every twenty-four hours. Though at the moment I had no definite information on the subject, I felt sure that Canadian diesels did not get such frequent attention, and from the details in the preceding paragraph it is clear that the transcontinental machines, at any rate, cover 2882 miles during three days without going over a pit. This reminds me of another point that came up during our conversation ; I had ventured to suggest that possibly there might be rather too many differing types of diesels in Britain, making standardisation difficult to say the " standard " designs, and should be able to build them more or less on " assembly-line " methods, as is now the case in America. The why and wherefore of these varied types, each maker having its own, was explained to me, and I see the point—which I need not touch on here—but can only say that if correct, " 'tis true 'tis pity, and pity 'tis true "—I think standardisation would have been better. A more or less " basic " design should have been decided upon after full and lengthy trial and test, extending over years if necessary, and then all makers should have been instructed to build to that design.

A minor criticism ; illustrations of the R.D.C. car show the motors and associated gear completely enclosed in easily detachable housings, well protected from dust, damage and weather. Last year, when in England I rode several times in railcars, which ran very well indeed, but the motors and accessories seemed to me rather unprotected, in fact, not enclosed at all, which is not only unsightly, but surely not an ideal arrangement. The engine of a motor-car is not left out in the open at the mercy of the elements, to collect dust and dirt ; why should that of a railcar ? The modern

trend is to enclose and protect intricate mechanism ; I am sure this little blemish will not remain indefinitely—it should not have been allowed in the first place !

Fuel consumption was another subject about which inquiries were made. In the mountain region between Revelstoke and Calgary, three units with fifteen cars, about 1200 tons, consume 840 gallons of fuel, the equivalent of 1·06 gallons per unit mile. On the prairie between Calgary and Winnipeg, 832 miles, with thirteen to fifteen cars, 1235 gallons or 0·75 gallons per unit mile are the corresponding figures. Over the 2882 miles from Vancouver to Montreal the total per locomotive averages 5184 gallons, approximately 1·8 gallons per mile. These figures are all for propulsion fuel only, not including the oil used for train heating.

An observer in the cab of a diesel engine cannot fail to notice how much more comfortable and less exacting are the conditions and duties of the enginemen ; the luxurious seats, air-conditioning, the wide unobstructed look-ahead, the window-wipers, the linoleum-covered deck, the toilet—not actually in the cab, but it is available !—the absence of dust and grime, and of anything worth calling physical effort. After an hour or so, passed very pleasantly cheek by jowl with the fireman discussing this and that, the conversation only momentarily interrupted by his observations of the automatic colour-light signals dutifully exchanged with the engineer, who verbally acknowledges them, and every half-an-hour or so by his brief disappearance into the engine-room to reassure himself that the Clarkson generator is not soldiering on the job—after this, one cannot help wondering whether a " fireman " is really needed at all ; if he is, he earns his money very easily ! I may safely confess now—it would not be exactly diplomatic to do so in the cab, and I have never dared to even hint it there—that in my view he is not, and that the few who are still there will not be there much longer ! I do not quarrel with the dictum that there should be two men in the cab ; the idea of the driver—pardon, " engineer "—being alone is not attractive, but all that is necessary is a man to act as additional look-out, not a highly paid " fireman " demanding employment to carry out duties that no longer exist. It is conceivable, even likely, that circumstances might arise in which the presence of a second man in the cab might make the difference between safe operation and delay or accident. The foregoing applies to diesel engines on passenger service ; where freight trains are concerned, a fireman is clearly superfluous, as not only is the Clarkson generator inoperative, but the head brakeman rides in the cab anyhow, thus providing the desirable look-out and emergency helper. A fireman is not required on yard engines either, but I incline to the view that dual controls—on both sides of the cab—might be advisable ; perhaps not necessary, but advantageous.

It was on these two points—the necessity or otherwise for firemen on passenger and yard diesel engines—that the unions and the company locked horns a couple of years ago, when a strike was threatened that might have brought a nation-wide tie-up and put thousands of other men out of work, all merely to keep a few score junior firemen " feather-bedded " in practically non-existent employment. Fortunately the company refused at long last to be blackmailed, dug its toes in and reached an agreement with the firemen's organisation on the basis of the Kellogg Royal Commission of 1958, to the effect that firemen with a seniority prior to April 1, 1956, will continue to be employed on locomotives of the type to which they had until then been assigned, without prejudice to their existing seniority rights for promotion to engineers. The result, of course, will be the eventual disappearance of firemen on diesel passenger and yard engines, as they are promoted to engineers ; further, no new firemen are being hired by the company. So, in the not very distant future the fireman's occupation will be gone, and he but a memory ; presumably his seat on the left of a passenger diesel's cab will be occupied by a mere look-out as suggested above. Looking farther ahead, possibly there will be no engineers either ; in fact, nobody in the cab—the train will be " remote controlled " from a Despatcher's office. Yes, no doubt that will come—it has already been done experimentally with electric trains in France, and nobody need tell me that diesel locomotives, with or without two people in the cab, are going to rumble about indefinitely! I shall not see this come about, but you, the reader, very likely will ; I am content that you should have the pleasure.

In Canada, enginemen's earnings per day are figured on what is known as " the dual basis of pay "; for passenger service this is 100 miles or less, and five hours or less ; for freight service it is 100 miles or less, eight hours or less. Under the agreement there are certain exceptions to the above figures, but for general purposes they are correct.

I have long been of the opinion that there is a great deal of " feather-bedding " on North American railways, and that enginemen have had a good share of it—and still have. What is " feather-bedding " ? It is a loose term covering many things, including (1) men being paid for doing nothing ; (2) doing useless work ; (3) still being paid " hard-lying " money as compensation for hardships that modern technical advances have long since banished. For instance, the " mountain differential " which firemen were paid until two years ago, which the Kellogg Royal Commission finally removed from the statute book. In the days of coal-burning, hand-fired locomotives, the fireman really did earn his money in the mountains ; engines were big, gradients severe, and conditions often very hard, so he was paid something extra—about 5s. 8d. per 100 miles—for his exertions, and I have no doubt thoroughly deserved it ; this was the " mountain differential." But coal-burning, hand-fired locomotives disappeared from the mountains at least twenty-five years ago to my knowledge ; during the whole of that period, when riding in the cabs of all sorts and conditions of engines, I never even saw a fireman handling a scoop ; the engines were either mechanically stoked or oil-fired, with the result that every one of the firemen with whom I rode spent most of his time talking to me, not shovelling coal—he was more likely to get lockjaw than lumbago. Yet he received the " mountain differential " to offset his backbreaking labours ! And did so until two years ago ; now he receives the " valley differential," which is substantially less, but for various reasons too involved to be dealt with in this article, his monthly pay in the aggregate on diesel work is only very slightly reduced. Yet bear in mind how very much pleasanter and less demanding in every way is the work of a fireman on a diesel engine in comparison with that for which the " mountain differential " was originally instituted, and, in fact, how very easy and " soft " his job is nowadays. I cannot for the life of me see why he should be granted any differential at all, either mountain or valley ! After having had a great deal of experience of British Columbian conditions, in the cabs of both steam and diesel locomotives, during which I watched everything that went on—it was what I was there for—I cannot see that a diesel fireman's work in the mountains is any more arduous than it is on the prairie, so why should he be paid more for doing it ? The reader may ask " What is he actually paid ? " Herewith the figures :

Three-unit diesel engine passenger service, 4800 miles per month, with mountain differential, £52 per week ; valley differential, £50 per week ; three-unit diesel engine in freight service, 3800 miles per month, with mountain differential, £48 per week ; and valley differential, £46 5s. per week.

On the basis of these figures I leave the reader to form his own opinion on whether the fireman deserves or needs any differential—I know what mine is ! However, ultimately the question will solve itself by the disappearance of the fireman. The Canadian engineman has a far easier job than his British opposite number, and in my opinion is overpaid for doing it, which is not the case with the Briton ; the fireman in my native land has my sympathy, his Canadian counterpart has not ; look at the above figures ! He never has to do long runs ; 100 miles is still reckoned as a day's work ; that is, it is the basis on which his pay is figured, in the same way that 140 miles is in Britain. He never has to go beyond the next divisional point, which is seldom more than 130 miles distant, and is often less. This leads to conditions which would seem to closely approach " feather-bedding "; for example, the " Canadian " covers the 2882 miles between Vancouver and Montreal in 70·45 hours, and requires twenty-two crews, who relieve each other on an average every 131 miles. The shortest run is that between Moose Jaw and Swift Current, made in seven minutes under two hours ; the longest are in the mountains, taking a little over four hours respectively. There are no turns in Canada corresponding to London–Plymouth, 226 miles ; London–Carlisle, 299 miles ; or Leeds–London and return in the day, 372 miles, with only a hour and a quarter between the two runs, the toughest " day's work " for a fireman I have come across in England. Compare that with any one of the ' Canadian's ' " between divisional points " turns ; the fireman sitting snugly in his seat for two or three hours, only leaving it three or four times during the run, and my friend Fireman —— of Copley Hill (Leeds) really *working* for eight hours (including shed time) on a rough-riding "A1," manhandling 8 tons of coal into a firebox somewhat farther away from the bunker than it need be, attending to injectors and signals in his spare time. Not for him relaxation and boredom in a foam-rubber armchair ; it is all very different, and so is the remuneration. Fireman —— of Revelstroke draws £50 at the end of the week ; Fireman —— of Leeds draws—I know, but will not mention it ! It is not enough. The average British fireman certainly is not " feather-bedded "; in comparison, his Canadian opposite number is ; yet, in common with most of the country's workers, it seems he is never satisfied.

In addition to receiving payment for actual running time, enginemen are allowed certain fixed amounts—termed " arbitraries " for preparatory work on their engines at initial terminals, but not on taking over an engine *en route*. For instance, at Vancouver

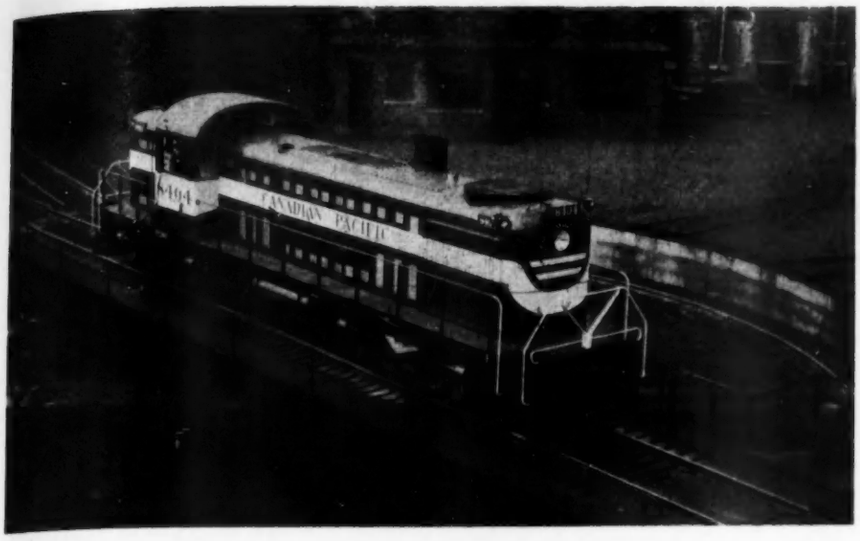


Fig. 22—C.P.R. diesel road 1500 h.p. switcher

(quoting Mr. Emerson, vice-president, C.P.R.): "Firemen are now paid initial terminal time from the time they report for duty until departure from the initial terminal, the time they are called to report for duty being determined by the company's officers at the various locations, which is dependent on the circumstances surrounding each instance. In so far as locomotive enginemen are concerned, they are paid an arbitrary of fifteen minutes for preparatory service; this allowance is paid over and above the initial terminal time. Firemen reporting for duty at a change-over point (i.e. divisional point—E. H. L.) where engines run through are only called sufficiently in advance to enable them to get on their locomotive. . . . This fifteen-minute allowance is a reduction from the arbitrary allowances in effect a few years ago (on steam locomotives—E. H. L.), and closely reflects the time required of an engine-man for actual preparatory service." This appears fair enough; at divisional points, where the crews change, there is nothing for the oncoming crew to do, water and fuelling being done by "ground crews," just as it was in the days of steam, when cleaning of ashpans, greasing of motion, &c., could not be done by the enginemen due to lack of time—there was always a "ground crew" on hand ready to rush these jobs through.

I pondered over all this during the remainder of the journey to Toronto, from my berth, from a reclining seat in a coach, and from an equally comfortable vantage-point up in the Dome, which really is the finest place for general observation in the train, including the engine, as it gives an all-round look out. It is perfectly air-conditioned, and under a blazing sun is neither over hot nor dazzling, the glass being slightly tinted and treated to exclude ultra violet-rays. There are two "Dome" cars in the train, the forward one, containing at one end the coffee-shop at the foot of the stairs up to the Dome, and at the other end a coach section with reclining seats; the rear Dome (Fig. 18) is combined with a lounge sleeping-car. It is a great convenience and economy to be able to get snacks or full meals in the coffee-shop at reasonable cost, and at any time of day, which cannot be done in the dining-car; the meals there are exceedingly good, the choice on the menu very wide, but it is only to be expected that the prices correspond—hence the advantage of the coffee-shop (Fig. 16). It is fatuous to compare, as silly people often do, the respective accommodation and the amenities of a three-day or four-day train in Canada and a less-than-one-day train in Britain; the requirements are altogether different. As well compare the accommodation on the "Queen Elizabeth" with that of the cross-Channel "Invicta."

The first part of the transcontinental journey from Victoria through Vancouver to Calgary, was dealt with in some detail, but the succeeding 2062 miles to Toronto will be passed over, not as being unworthy of description but because it would all be repetitive. Suffice it that the "Dominion" arrived there on a Tuesday, at 7.20 a.m., twenty minutes late—Victoria had been left at 9.30 a.m. the preceding Saturday. Granted a plane could have done the journey in single-figure hours, but I should not have enjoyed it, and should have had nothing to say about diesel locomotives or the men who handle them. It is time somebody did.

Times, methods and motive-power have changed during fifty years on the C.P.R., as these articles have shown, but not everything has done so—train No. 36 still leaves Toronto for Montreal at 9.30 a.m., just as it did over half-a-century ago, and the writer boarded it again for Norwood, ninety-three miles east, once more intending to stop-off there just as he had done then. The coach was far more comfortable, air-conditioned, and the engine was a diesel road-switcher, 1500 h.p. (Fig. 22), in place of a 4-6-0 or a "Pacific"—first introduced on the C.P.R. in 1906, and "run-in" on this line and service—but the schedule was identical, as was the arrival time at Norwood, 12.03 p.m., and the fourteen intermediate stops. This line, through Peterboro and Smiths Falls to Montreal, and the corresponding train No. 35 leaving Montreal at 10.15 a.m., together with the post-war motive power, a 4-4-4 engine built as a sort of mixed traffic edition of No. 3001 (Fig. 19) with 6ft 3in wheels, were described in THE ENGINEER, July 25, 1941. This route is the second of the C.P.R. lines between Montreal and Toronto, diverging from the other at Glen Tay, from whence double track extends to Montreal, 144 miles, into which city, four travelling days after leaving Victoria, we come to a stand in the Windsor Station, at 7.25 p.m. It had been an interesting journey, one which is always enjoyable despite the many times the writer has done it; familiarity has not bred contempt, nor will it induce him to board a plane to make the trip in the future—unless, of course, there are no longer any trains, which is unfortunately within the bounds of possibility.

I am much indebted to many officials of the C.P.R. for their assistance in the preparation of these articles, among whom I must mention in particular Mr. Emerson, vice-president; Mr. Leo George, superintendent of motive power, for checking the technical details; Messrs. Coleman and Neild, of the respective Public Relations Offices in Montreal and London, for photographs, &c. Also General Motors, Diesel, Ltd., London, Ontario, and the Budd Company, Philadelphia, for information of value, photographs, &c., without which the articles could not have been written.

Institution of Electrical Engineers Annual Dinner

THE annual dinner of the Institution of Electrical Engineers was held at Grosvenor House, Park Lane, London, W.1, on February 23. Proposing the toast of "The Institution," the Rt. Hon. Richard Wood, M.P., Minister of Power, said that the electrical supply industry was well served by its engineers, who had risen to the challenge of the recent phenomenal growth in demand for electricity. Through the efforts of engineers, continued improvements had been secured in the thermal efficiency of power stations, and in 1959 the output of electricity per ton of standard fuel was one-quarter greater than ten years before. Despite this, the amount of coal needed for electricity generation increased by 5,000,000 tons last year, and their industry therefore gave a great uplift to the prospects for coal, and much needed relief to ministerial anxiety.

Sir Hamish D. MacLaren, President of the Institution, replied to the toast. For over two years, he said, the Institution had been grappling with the problem of its specialised sections, and this was the occasion to appeal to all for a bold and imaginative approach to this question of making some realignment. They must also be aware of the need for more cohesion in the engineering profession as a whole. He was not sure that amalgamation as such should be their goal, but there was need for an organisation able to speak for engineering as a whole with one voice, such as a joint Council. He suggested a kind of "supra" institution with a membership of corporate members of existing institutions, having a status something like the Bank of England in the banking world. In education to-day he saw a danger of too early specialisation and asked whether it would not be better to use some of our so-called affluence in time and money in preparing our future citizens for their careers. He would not suggest in the first place extending the school leaving age, but we should aim at giving 5 per cent or so of the coming generation who were endowed with the best brains a more universal approach to their working life. It was on this small percentage that the future of our country depended. For the early specialisation now required, the universities were not without blame for the high standards they demanded in subjects for further study. An almost irrevocable choice had to be made by boys between the ages of fourteen and fifteen. There would be an advantage in providing a broad general education up to seventeen, followed by one or two subjects for specialised education. This would be better even if it meant spending an additional year at the university.

The toast of "The Guests" was proposed by Sir Willis Jackson, immediate past president, who referred in his speech to a conference to be held in Warsaw on March 21 and 22 at which ten papers on telecommunications and traction will be read by British engineers. The Hon. W. T. M. Beale, Minister for Economic Affairs, American Embassy, replied. Speaking of the complex and interconnected problems facing the U.S.A. at home and in international affairs, he said it was their intention to adopt measures which would benefit all and to seek their objectives through co-operative means.

400kV Oil-Filled Cable

A 400kV Pirelli-General cable system which has been subjected to C.E.G.B. type-approval tests is described. The accessories included in the test were a straight joint, a stop joint, an outdoor sealing end and an oil-immersed sealing end. A description is also given of the new high-voltage cable testing laboratory at the Pirelli-General Eastleigh works, where the tests were carried out.

A 400kV oil-filled cable assembly, including a range of accessories, was recently type-approval tested at the official opening of the high-voltage cable testing laboratory of the Pirelli-General Cable Works, Ltd., at Eastleigh, Hants. The tests were witnessed by members of the Central Electricity Generating Board and a number of consulting engineers. This cable system has been developed and submitted for type-approval tests, in anticipation of the C.E.G.B.'s decision to uprate the supergrid system to 400kV.

The cable itself is a low-pressure, oil-filled cable designed on the same basis as its counterparts for somewhat lower voltages. As illustrated here it is of single-conductor make-up. It has an overall diameter of 4·1in and further details and dimensions are tabulated below.

Conductor cross section	0·9 sq. in
Maximum stress at working voltage (nominal)	160kV/cm
Insulation thickness (minimum)	0·90in
Impulse voltage withstand level	140kV
Maximum continuous conductor temperatures :	
laid direct	85 deg. Cent.
in ducts	85 deg. Cent.
in air	85 deg. Cent.
Capacitance per 1000 yards	0·188 μFd
Charging current per 1000 yards	13·6A
Typical current rating :	
Three cables laid side by side with 12in centres at a depth of 3ft 6in in soil of g=120 deg. Cent./watt/cm (p.f. of 0·0025 at 85 deg. Cent.) 760A, and in soil of g=60 deg. Cent./watt/cm (p.f. of 0·0025 at 85 deg. Cent.) 975A.	
Dimensions and design details :	Diameter
Oil duct	8mm
Steel spiral	9·02mm
Conductor	32·9mm
Conductor screen C.B. paper	33·8mm
Insulation W.P. paper	81·2mm
Insulation screen C.B. paper interlocked with perforated metallised paper	81·75mm
Lead alloy sheath	88·36mm
Impregnated cloth tape	
Six plain copper wires longitudinally applied.	
Impregnated cloth tape	
Two H.D. tin bronze tapes ½in by 0·006in in parallel	89·89mm
QR2QH2 serving overall	104·27mm

A three-phase circuit, consisting of three such single-core cables, laid side-by-side in the ground at a spacing of 12in centres, would have a continuous power transmission capacity of 528MVA to 675MVA over the range of soil resistivities normally encountered.

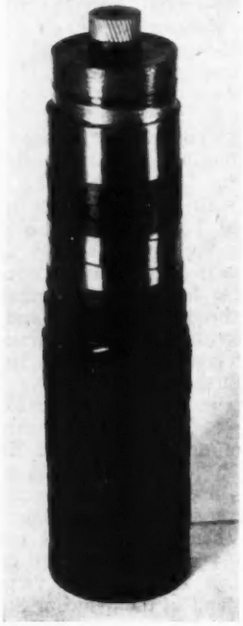
A range of accessories is available for use with the 400kV cable : it consists of an outdoor sealing end ; an oil-immersed sealing end, whereby the cable can be terminated in the entry chamber of a transformer ; a straight-through joint and a stop joint. These accessories are illustrated in the pull-out drawing facing this page. It will be appreciated from the dimensions given that these drawings are not to the same scale.

Impulse testing of the cable system was started at 1400kV which is the declared withstand level for the 400kV cable. After the application of ten negative and ten positive impulses at 1400kV the voltage was raised in 50kV steps to a level of 1600kV, with ten negative and ten positive impulses at each level. The test ended at 1600kV without breakdown of the assembly.

Other tests included load cycling : the cable was heated for six hours and then cooled for eighteen hours, this cycle being repeated twenty times, during which the cable was subjected to a voltage of 308kV, which is one and a third times the working voltage, core to earth. Power factor measurements were made during each load cycle to determine the thermal stability of the cable insulation.

High Voltage Laboratory

The high-voltage laboratory in which these type approval tests were carried out is housed in a new building in the company's Eastleigh works. It replaces the previously existing high-voltage laboratory which was described in our issue of February 3, 1956, page 170. Some of the test equipment described below was transferred from the old laboratory and the rest has been added, but the new building provides greatly increased space and improved working conditions.



400kV, 0·90 square inch single-core, paper-insulated, lead-sheathed, oil-filled cable. Maximum stress at working voltage (nominal) 160kV per centimetre

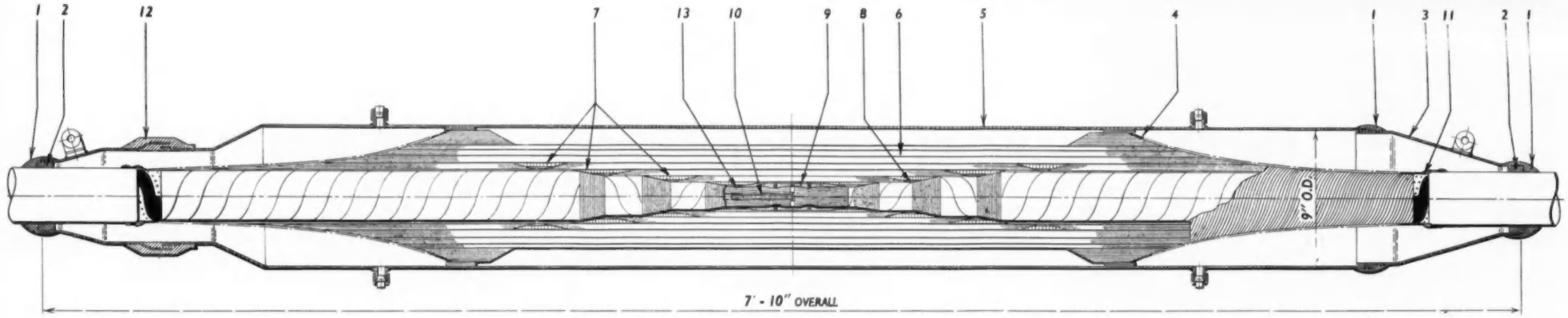
Floor space is a very important requirement. For example an experiment on a new design of 132kV, three-core straight joint involves the erection not only of the joint itself but also of six sealing ends and two splitter boxes requiring an area of at least 1500 square feet. If the test in question is a type test on a new design of cable, it is usually necessary to include in the test assembly each type of accessory intended for use with the new cable and even more floor space is required. Moreover, such tests may continue for weeks or months and in some cases as much as twelve months before approval of the new design is given. If work is to continue on a number of projects simultaneously, the importance of adequate floor space becomes paramount.

Another important requirement is adequate height. To test cable systems for the highest voltages in use to-day, impulse voltages of 1·6 million to 1·7 million volts are required Even higher voltages may be needed in the future. The impulse generator described below is 26ft high and the roof of the building must allow adequate clearance above the top of the generator.

The new laboratory building meets these requirements by having a floor area of 13,500 square feet, the height to the apex of the roof of the main test bay being 60ft, which not only allows adequate clearance at present but provides for the addition of a further stage to the impulse generator. The building is divided into two bays, the larger of which is 125ft long by 70ft wide. This bay is used for the highest voltage testing and is of portal frame construction thus eliminating roof trusses. The height to the apex of the roof is 60ft and the height to the eaves 57ft. The smaller bay is 70ft by 65ft and has a pitched roof with a height of 32ft to the eaves. Both bays are steel framed with aluminium sheeting and an insulating lining. The floor is of red quarry tiles to avoid the dust inevitable with a concrete floor.

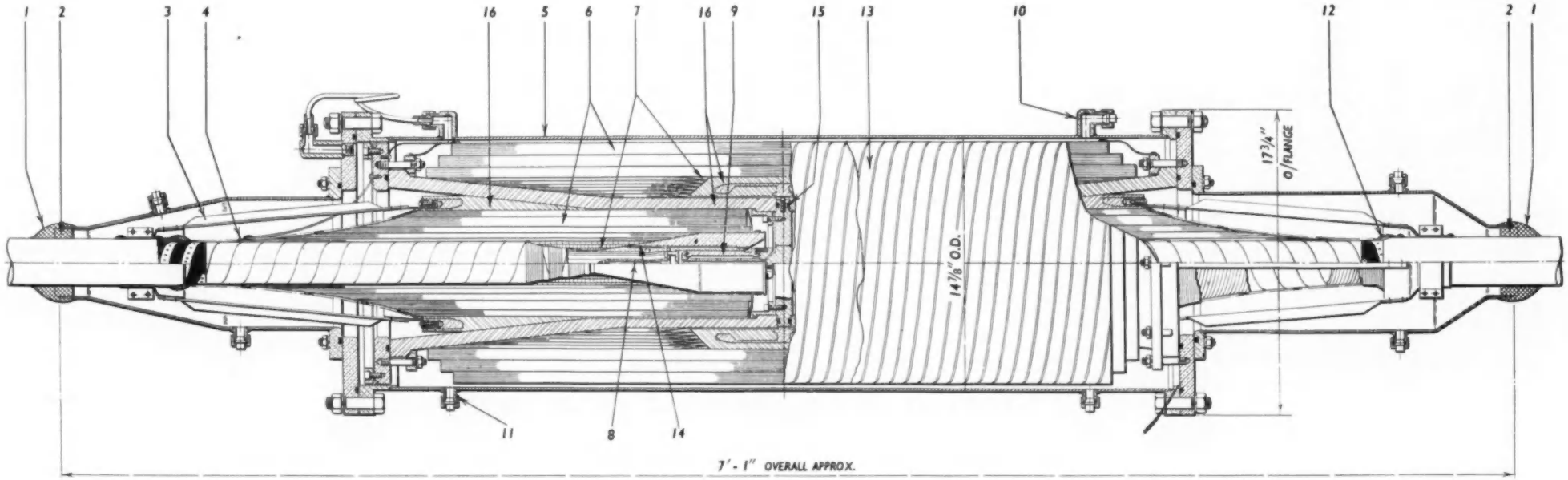
Lifting facilities in the larger bay will be provided by a 2-ton crane (to be installed shortly) with a maximum height from hook to ground level of 48ft, and capable of passing over the highest test equipment in the laboratory. In the smaller bay lifting is by

400kV OIL-FILLED CABLE ACCESSORIES



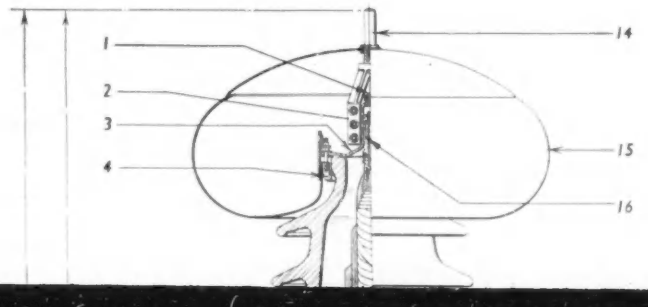
400kV straight joint for cable of 0·9 square inch cross section, 8mm duct

1—Wiped joint.
2—Lead strip packing.
3—Copper end.
4—Tinned copper wire stress control.
5—Copper casing.
6—Paper tube insulation.
7—I.C.O. paper tape filling.
8—Varnished nylon tape.
9—Copper socket
10—Steel plug.
11—Tape poultice.
12—" Voltalit " insulated joint.
13—Carbon black over conductor.



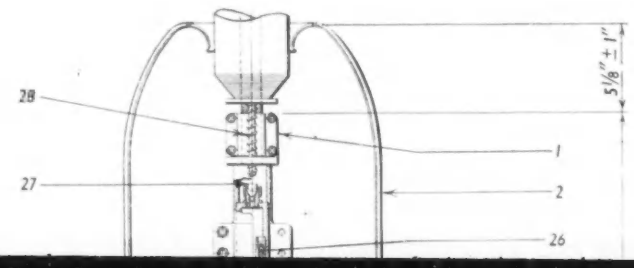
400kV stop joint for hollow core cables up to and including 1·0 square inch cross section, 12mm duct

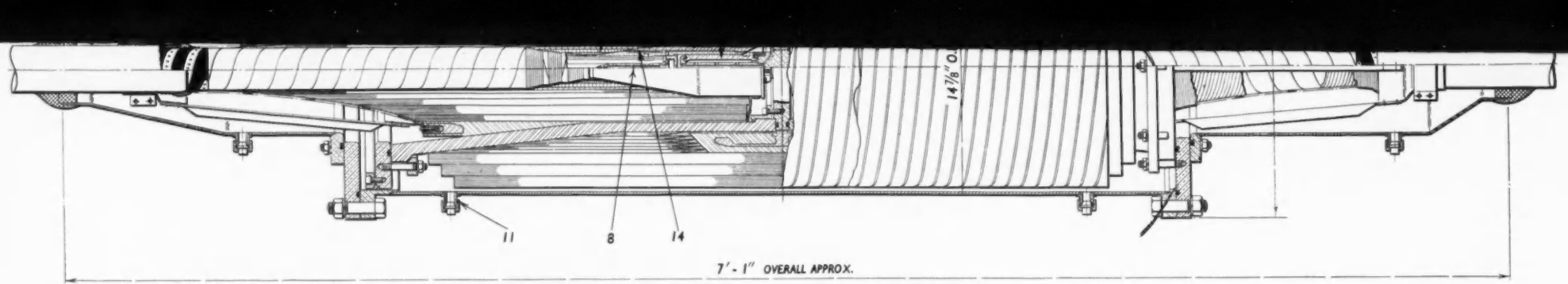
1—Wiped joint.
2—Lead strip packing.
3—Gaiter.
4—Tinned copper wire stress control.
5—Casing.
6—Paper roll insulation.
7—Tape filler.
8—Steel plug.
9—Plug-in contact.
10—R.A. oil connection.
11—Union.
12—Nylon tape poultice.
13—Copper tape screen.
14—Copper socket.
15—" O " ring seal.
16—" Voltalit " moulding.



(Left) 400kV outdoor sealing end

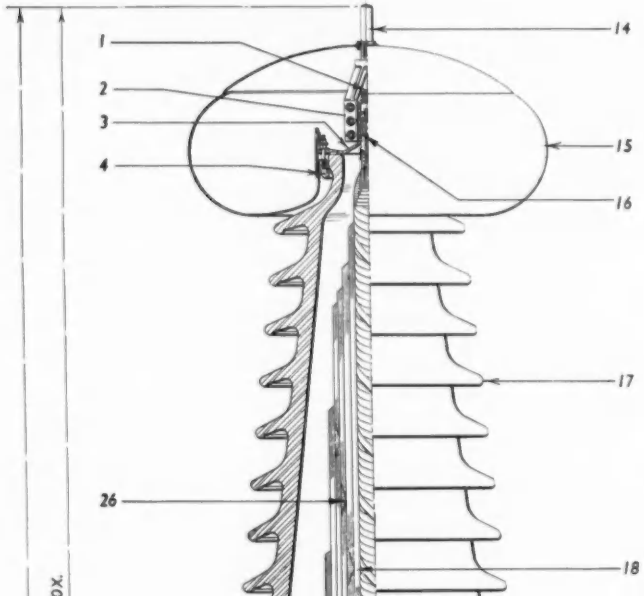
1—Special blank nipple.
2—Forked end.
3—Top cap casting.
4—Top ring casting.
5—Stress shield.
6—Steel band.
7—Steel angle ring.





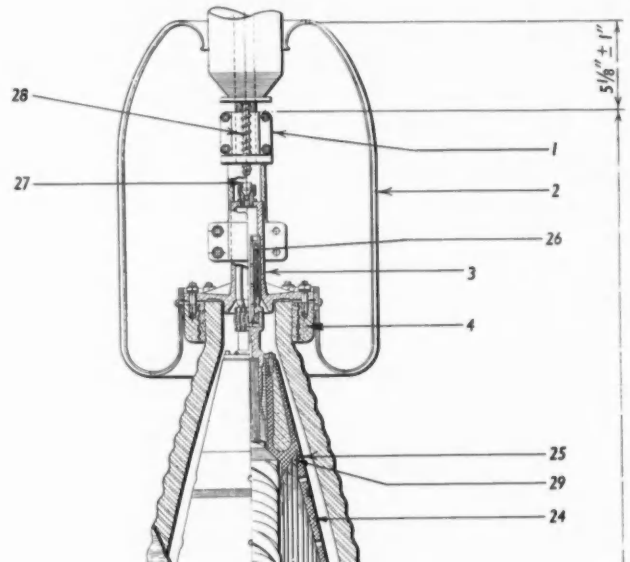
400kV stop joint for hollow core cables up to and including 1·0 square inch cross section, 12mm duct

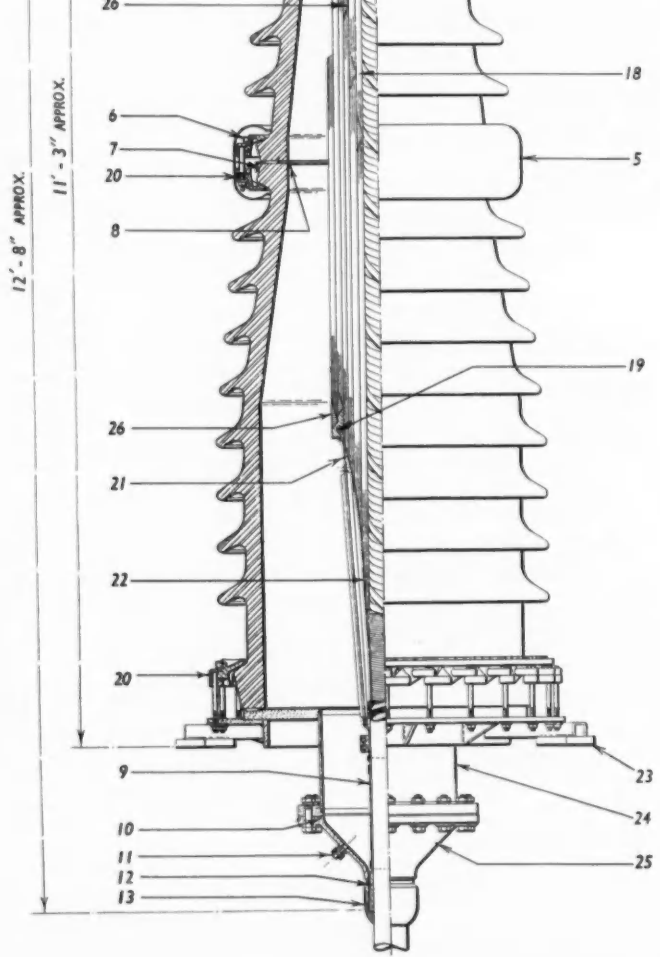
1—Wiped joint.
2—Lead strip packing.
3—Gaiter.
4—Tinned copper wire stress control.
5—Casing.
6—Paper roll insulation.
7—Tape filler.
8—Steel plug.
9—Plug-in contact.
10—R.A. oil connection.
11—Union.
12—Nylon tape poultice.
13—Copper tape screen.
14—Copper socket.
15—" O " ring seal.
16—" Voltalit " moulding.



(Left) 400kV outdoor sealing end

1—Special blank nipple.
2—Forked end.
3—Top cap casting.
4—Top ring casting.
5—Stress shield.
6—Steel band.
7—Steel angle ring.
8—Bakelite ring.
9—Split copper sleeve.
10—" O " ring seal.
11—Blank nipple.
12—Gunmetal bush.
13—Wipe.
14—Copper terminal.
15—Corona shield.
16—Plug-in contact.
17—Porcelain insulator.
18—Paper roll insulation.
19—" Voltalit " stress ring.
20—Articulated ring.
21—Gaiter.
22—Copper wire stress control.
23—Base.
24—Throat assembly.

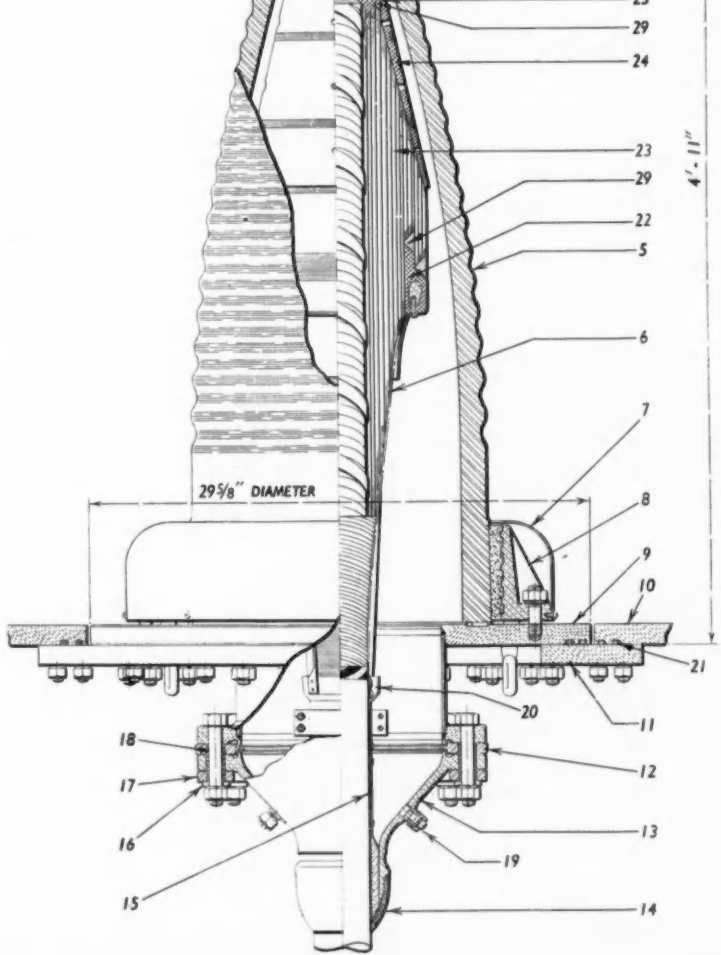


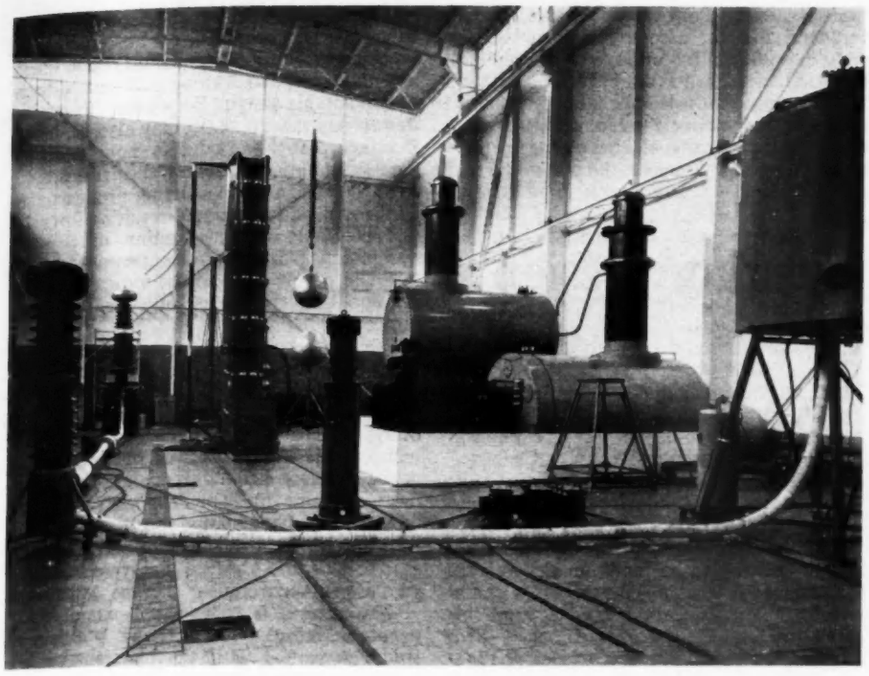


19—" Voltalit " stress ring.
20—Articulated ring.
21—Gaiter.
22—Copper wire stress control.
23—Base.
24—Throat assembly.
25—End bell.
26—Tape filler.

(Right) 400kV oil-immersed sealing end for inverted use

1—Clamp connector.
2—Corona shield.
3—Top cap casting.
4—Top collar.
5—Porcelain insulator.
6—Copper wire stress control.
7—Bottom corona shield.
8—Bottom collar.
9—Sealing end flange.
10—Transformer wall.
11—Clamping ring.
12—Insulating spacer.
13—Bottom casting.
14—Wipe.
15—Split copper sleeve.
16—Steel washer.
17—Insulating washer.
18—Insulating sleeve.
19—Blank nipple.
20—Gaiter.
21—" O " ring seal.
22—" Voltalit " stress ring (bottom).
23—Paper roll insulation.
24—" Voltalit " stress ring supports.
25—" Voltalit " stress ring (top).
26—Plug-in contact.
27—Special blank nipple.
28—Steel springs.
29—Tape filler.





Main bay of the high-voltage laboratory showing an assembly of 400kV cable and accessories undergoing tests

means of a 1-ton crane with a maximum height of 27ft to the hook.

All the major items of test equipment are controlled from a central control room situated between the two bays at a height of 8ft above the laboratory floor. The control room is fitted with plate glass windows extending practically to floor level and sloping outwards from the floor, so that an almost uninterrupted view of the whole of the laboratory can be obtained.

The building is lighted by windows placed high in the wall around three sides of the main bay and by north-facing roof windows in the smaller bay. Artificial lighting is provided by eight 400W mercury-vapour lamps placed on the walls of the main bay just below the window level, and by eight smaller lamps suspended from the roof of the smaller bay. The decision to place the lamps on the wall of the high test bay was taken to simplify replacement of lamps which would become a major problem for equipment on the roof 60ft from floor level. Both bays are heated by a unit type, oil-fired warm air heater with a capacity of 1,500,000 B.Th.U. per hour.

The main items of test equipment for cable testing and development work are the impulse generator and high-voltage alternating-current testing transformer ; each bay of the new laboratory is equipped with both of these items. The larger bay contains a Micafil impulse generator with an open-circuit surge voltage of 2·4 million volts and a surge energy of 57 kilowatt-seconds. This generator is of somewhat unusual design in that all the capacitors are contained in a central column of Bakelised paper and is of comparatively small size in relation to its output. It was derived from the existing impulse generator in the old laboratory by the addition of an extra stage which increased the open-circuit surge voltage from 1·6 million to 2·4 million volts. It uses the well-known Marx circuit, having twelve stages charged to a maximum d.c. voltage of 200kV, obtained from a mechanical rectifier. The generator is on rails and is movable to four alternative operating positions, thus allowing the maximum flexibility in the layout of test assemblies.

The impulse voltage wave is monitored by a resistance-capacitance voltage divider and transient recorder, with facilities for visual examination and photographic recording of wave shape.

High-voltage a.c. testing in the large test bay is effected by the use of two 500kVA, 333kV, Ferranti transformers, one of which is insulated from earth for 333kV so that, by means of a cascade connection, the maximum output voltage can be 666kV. These transformers are also used for power-factor tests by the Schering Bridge method using a standard condenser of the compressed-gas type, of 100 picofarads capacitance, and suitable for use up to 500kV.

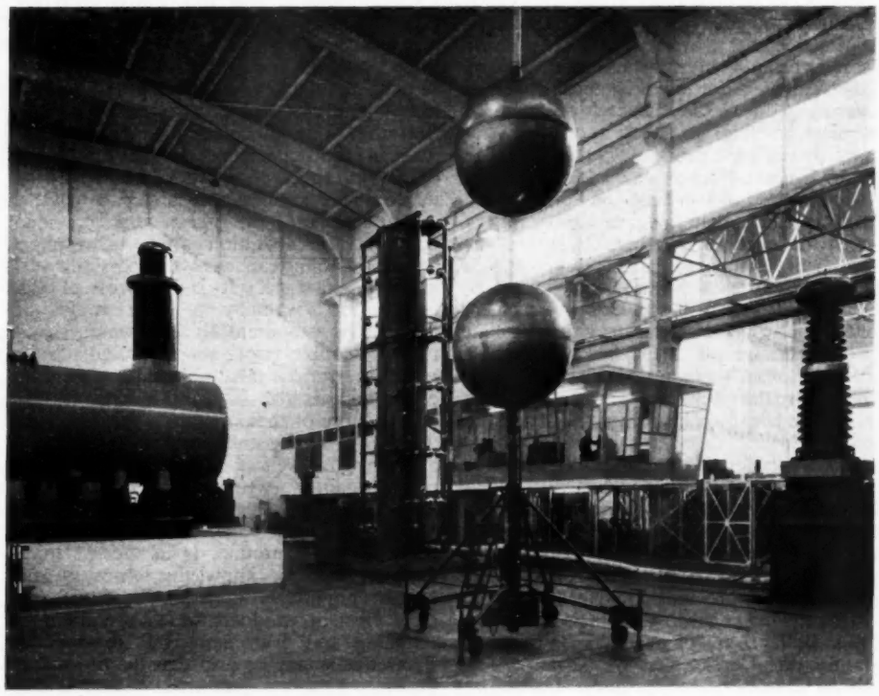
Voltage measurement in this bay is by means of a 1·5m diameter sphere gap. The upper sphere is suspended from the roof and can be lowered by means of a winch on one wall at floor level to permit the crane to pass when necessary. Two alternative positions are provided for the sphere gap.

In the smaller bay of the laboratory there is an 800kV Ferranti impulse generator, consisting of four 200kV stages, with a total surge energy of 22·4 kilowatt-seconds. High voltage a.c. testing is provided for by one 300kVA, 150kV Ferranti transformer and another 30kV, 100kVA transformer. A 50cm sphere gap is used for voltage measurement in this part of the laboratory and a 100kV, 100 picofarad standard condenser is available for power factor testing.

Often it is necessary to heat the conductor of cable assemblies undergoing test, and this is done by providing a link between the terminations of the cable so that the cable conductor forms part of a closed loop. The complete cable passes through the yoke of suitable step-down transformers and a current is induced in the cable conductor by this means. A total capacity of 275kVA, controlled by two induction regulators and available at five separate points in the laboratory, is used for the supply to these heating transformers.

Thermal resistivity is an important characteristic of cable insulation and is measured by passing a constant direct current through the cable conductor and making careful measurement of temperature drop through the insulation. The direct-current supply required for this test is provided by a motor generator with a capacity of 30kW and a maximum current output of 3000A.

A length of the 400kV cable, together with some of the accessories connected for testing, can be seen in the photographs reproduced here. The upper illustration shows, from left to right, a capacitor peak voltmeter, a 400kV outdoor sealing end (in the background), the Micafil impulse generator, a sphere gap, a standard condenser and the two 333kV Ferranti transformers. In the right foreground behind the cable is a small transformer for cable heating. A straight joint and a stop joint are included in the cable loop under test, as illustrated. To



The control room overlooks the laboratory floor, giving a clear view of all the high-voltage test equipment

provide stable conditions during thermal tests the cable is temporarily lagged with asbestos. Portable items of test equipment are mounted on castors.

For safety of the operating staff a comprehensive system of interlocking is provided between the control systems of the test equipment and the gates and fences of the test areas. Portable fences are used to surround the test assemblies to ensure the maximum flexibility in layout of the tests and these fences are coupled by plug and socket connections to one another and to points on the wall of the laboratory, so that the breaking of any of these plug-in links will automatically remove the test voltage.

Aesthetics in Engineering Design

By R. H. LITHERLAND*

ONE of the saddest features of our present educational establishments is the exclusiveness of the separate fields of knowledge which exist inside them. It is found not only between the fields or subjects, but also between the sections of the subjects themselves. However, it is particularly apparent between the two broad fields of activity—art and applied science. As a result of this, artists and engineers tend to be as remote from each other as the average Greek and Japanese—and for the same reasons too, for they have differing traditions and professional languages; and these create strong barriers to mutual communication. The full disadvantage of this chronic state of affairs is nowhere more apparent than in the field of engineering design. For instance, here, the work of artist designers may present ideas for engineering products which are pleasing in appearance, but also—unwittingly—mechanically inefficient, uneconomic in production, and completely dependent on the engineer's skill for their materialisation—and often correction; while the work of the engineer is very frequently the channel through which mechanically and structurally efficient, but at the same time appallingly ugly, engineering products spread far and wide all over the country as well as in our factories and homes. This same disadvantage may also be seen in the design of some instrument dials and meter faces, where the positive advantages of precision and mechanical accuracy are sometimes cancelled by their illegibility which makes them inaccurate in use. Sometimes this disadvantage leads directly to tragedy—as in the cases where inquests on aircraft disasters bring to light instances of mis-read dials. This negation of mechanical accuracy is generally due to the engineer's professional technical training, as a result of which he tends to design on a drawing board. He seldom has to use his products himself under a wide variety of working conditions. It is not surprising, therefore, to find controls placed on machinery where they are inconvenient to operate; where fire extinguishers in offices prove too heavy for typists to lift from their wall supports in an emergency; or where engineering goods remain unsold because of their lack of "shelf appeal." When this kind of situation arises, it is because the mechanical engineer lacks the knowledge of the applied physiologist and the artist.

This separation of knowledge into exclusive departments has not always existed. Galileo was not only an admirable scientist and a gifted musician, but at the outset of his career was undecided whether to become a painter or a scientist. During the Renaissance, many distinguished and gifted men such as, for example, Leonardo da Vinci, were very able in both art and engineering. In our own country, Sir Christopher Wren, the distinguished designer of St. Paul's Cathedral, London, was an architect, a mathematician and an astronomer. Imagine what would be the fate of Wren to-day if he was a pupil in one of our mid-twentieth century Grammar Schools! He would be a rather awkward case: difficult because no mental lopsidedness would aid easy classification. When the time came for the educational "parting of the ways," for the decision to be made on the number and names of the subjects of his General Certificate of Education course, and his future career, the effects of social propaganda combined with the present dominating influence in technology would make his specialisation in the sciences almost inevitable. He would most likely "drop" art. Eventually he would combine a possibly distinguished scientific or technological career with a personal tendency to become progressively æsthetically moribund. In the process we would lose the kind of engineering designer of which we are greatly in need of to-day when marketing and the human needs of operators are becoming progressively important aspects of engineering design.

This then is the background against which we have to consider the æsthetic design of engineering products. If they are designed by engineers, they will tend to lack the humanism which the applied psychologist and the artist designer would insist upon. In turn, the applied psychologist and the artist designer both lack the technological ability to give engineering products even the possibility of material existence in present-day industrial conditions. As a result, as there is a tendency—however unsound—to classify these products into "Capital" and "Consumer," the engineer designer usually dominates the former, and the artist designer often the latter. This can commonly and clearly be seen in the way heavy textile machinery differs in appearance from the mass-produced domestic sewing machine.

By "design" we mean the previous planning and definition which takes place before anything can have the possibility of material existence. It is a process of the imagination whereby a wide range of information—mechanical; economic; structural; possible processes of manufacture; æsthetic; functional; physical; chemical; psychological, &c.—is synthesised. If any one or more of these factors is missing from the design, or if insufficiently considered, the eventual effectiveness of the final product is correspondingly weakened. For example, inadequate knowledge of ultimate working stresses may well lead to structural breakdown whilst a product is in use. Also, a designer who lacks knowledge of posture and human physiology may produce mechanically efficient products which are difficult, fatiguing and even dangerous to operate. From this it may be seen that the process of design, which is a fusion of relevant knowledge, is to-day made difficult by the exclusiveness of the separate branches of this knowledge. It is possible for an engineering designer to be unaware of knowledge which already exists, and which could have a direct bearing on his design. Sometimes this may be due to ignorance; but it may also be due to the fact that knowledge is now often inaccessibly buried in remote specialisms.

In the design of engineering products, one of the main disadvantages resulting from the possible lack of consideration of essential design factors is that in this present technical age, the purely mechanistic view either predominates over the æsthetic, or ignores it altogether.

What do we mean by "æsthetics"? The word frightens most engineers: and this fear is frequently expressed in the form of ridicule. Their distrust of art and æsthetics may be due to the powerful influences and beliefs which made the protests of nineteenth century æsthetics against the slums, squalor, drudgery and filth of Victorian industrial towns so ineffectual and hopeless—the entrenched belief of the Establishment that the sacrifice of life, health, enjoyment and a wholesome environment can be sanctioned and excused if it brings in a commercially profitable return. "Aesthetics" is a field of study concerned with the reactions of the senses and the brain. It is the science or exact study of perception. It deals with the way we react to sensory experience. Unfortunately, since Baumgarten wrote his philosophical treatise on the nature of beauty (Frankfurt 1750–58), and used the word "æsthetic" in connection with this, we have tended to confuse æsthetics with beauty; whereas the æsthetic reaction to beauty is only one of our possible reactions when we perceive objects and experience sounds, tastes, &c. The reactions of our many senses can range from acute pain, through discomfort, irritation and indifference, to those perceptions which are tolerable, likeable and pleasant; ultimately to the experience of great beauty itself. These reactions may be experienced in relation to natural phenomena, such as to the forms, scents and colours of flowers, and to the colours and shapes of crystal formations. They may also be experienced in connection with man-made objects. For example, in driving a motor-car, we can not only see if the producer has taken pains so that its appearance is pleasing, we also notice if he and the road engineer have created the necessary conditions to give us a smooth ride with an absence of unpleasant vibration.

As I have pointed out it is often possible to have a pleasurable æsthetic response to nature—to landscapes, the colours of the evening sky, the forms of plants, &c., where no human intervention is involved. These same reactions can be experienced also to man-made products, such as to certain aerodynamic forms, to the beauty of the turbine blade, where there has been no conscious effort made to make them look pleasing. On the other hand, where there is a conscious aim to make engineering products expressive of beauty, this lies within the sphere of the artist—whether he is recognised as a specialist artist designer, or whether we use the term to describe the "artist" in every person. The professional artist is, of course, concerned to express a wider range of emotional experience than the reaction to beauty, but nevertheless it is an important part of his work. Also, since he deliberately aims to affect our æsthetic perceptions, he has great professional expertise in the many ways of doing this. It is for this reason that the finest actors have clear diction; that the finest artist typographers produce the most

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beautiful and legible letter forms; and that the most skilful furniture designers produce chairs which are a joy both to look at and to sit on. It is this same æsthetic concern which can make the disposition and sequence of controls on an instrument display panel easy to follow and understand; and make a scientific instrument, used to record and give information, easily and clearly legible in use; and result in the hand controls on a machine tool being dimensioned and placed in such a way that they are comfortably convenient to an operator.

The place of æsthetics in the design of engineering products is to " humanise " them. When we set about including this aspect of design, we usually do so for three broad reasons. First, because it is a natural human tendency—only denied by maladjusted people—to try to make the human condition and environment as pleasant and wholesome as possible; whether it is the living-room, the commercial office, the works canteen or the factory. Second, because when a selection is made from a number of similar products all in much the same price-range, the final choice is usually made on grounds of quality—that is on appearance and performance. Products which are convenient to operate and of good appearance are generally more commercially successful than those which neglect these factors; and this is particularly so if the market concerned is highly competitive. Third, because in prosperous, civilised and highly industrialised societies, operators demand industrial and commercial equipment which is designed with their operational convenience in view; and also because managements usually find it economically wise to use equipment which is pleasant for operators to use, and which is safe, efficient and comfortably convenient from a human point of view—where men feel that they can master machines, instead of the reverse.

There are senses other than the visual through which we feel æsthetic reactions: smell, touch, sound, ease of physical movement and mental comprehension, reaction to temperature, awareness of atmospheric pressure and humidity, vibration and balance. Many of the " human " sciences, such as psychology, physiology, neurology and biometry, are sources of information which enable the engineering designer to plan with these other senses in view. Anthropometry—the study of human proportions and dimensions—can enable instruments to be conveniently arranged for human use, so that, for example, dials and controls are in positions and on levels where thay can be easily seen and operated. Ergonomics—the study of the relationship between man and equipment of all kinds—is the combined field of applied psychology, physiology, and neurology. In accepting the basically organic nature of man, all these fields of study hold the view that products and machines should be designed in harmony with man's senses, physical nature and mental needs—a point of view which received little or no attention in nineteenth century industrial England.

Some of the ways in which engineering products are designed to make them pleasing to prospective users might be described generally as those which use methods of psychological persuasion. One of these is by stylistically treating products so that they appear to be better than they really are. The engineer's professional training usually makes him highly suspicious of this, and it is one of the causes of his distrust of the artist designer— though he usually forgets that he, too, is sometimes called upon to adjust his professional ethics to commercial convenience. One common feature of this type of stylistic treatment may be seen in the way certain over-glossy, chromium decorated motor-cars, with their exaggerated aerodynamic " fins," give a visual promise of a far better performance than the car is capable of. Another may be described as " science-fiction " styling, where engineering products are designed to resemble forms which have resulted from scientific developments which in their turn have gripped the popular imagination. It may be seen, for example, in the use of aerodynamic forms for quite static objects; the widespread use of the " rounded-square " shape of the television screen, for speedometers, ventilators, &c.; and the use of shapes derived from rockets for motor-cycle and motor-car body designs. Many of these pseudo-scientific design treatments may often be seen applied to instrument controls on a wide range of consumer engineering products, such as cars, radio and television sets; electric cookers; small power tools; &c.—apparently with great commercial success, though sometimes seriously diminishing the efficiency with which the products should be used.

In the present state of divergence between art and science, where the engineer places emphasis on function, strength of material and production convenience, and where the technologist tends to dominate design, it cannot be over-emphasised that engineering products can only be judged efficient in performance if they work well in conjunction with the people who have to use them—the æsthetic aspect of engineering design aims to make a contribution precisely in that direction.

Controlled Fusion Reactions

The forty-seventh Thomas Hawksley lecture, " Controlled Fusion Reactions," by Professor P. M. S. Blackett, M.A., F.R.S., was given at the Institution of Mechanical Engineers, London, on February 22. The lecture contained a survey of the state of the art, based on published papers ; it described devices designed to produce for study dynamic self-pinched plasmas, semi-static self-pinched plasmas, magnetic compression, and ionic injection into a static magnetic bottle. The last part of the paper is reproduced here, giving the lecturer's conclusions and his views on future possibilities.

IN the course of a single lecture, it has only been possible to mention in any detail some of the main and simplest devices now in use for the study of those aspects of plasma physics which seem likely at present to have most promise for the eventual attainment of useful power from nuclear fusion reactions. It is convenient to envisage four distinct steps towards this goal.

The first is to construct a device which will give an adequate number of neutrons, arising from completely thermalised deuterium ions, to use them to make a sensitive diagnosis of the physical conditions of temperature and particle concentration in the plasma : such a device might be called a *diagnostic fusion reactor*.

For such a device to be useful, it is necessary that neutrons arising from reactions due to directly accelerated ions should be absent. In most devices so far made, any neutrons of the right sort, that is, those from truly thermalised ions, have been diluted by a much greater and uncertain number of neutrons of the wrong sort, that is, those from directly accelerated ions. As Artsimovich[1] has put it: " The question of whether a given neutron belongs to the noble race of descendants of thermonuclear reactions or whether it is the dubious offspring of the shady acceleration process, is something that may worry the pressmen, but it should not, at the present stage in the development of our problem, ruffle the composure of the specialist. When the number of neutrons arising in a single discharge pulse reaches a value in excess of 10^{12}, then all doubt as to the origin of this effect will vanish." It should be noted that the wrong sort of neutron is especially likely to appear when very rapidly changing magnetic fields are employed, leading to large electric fields, and when the particle concentration is low, so giving long free paths before collisions. Conversely, they are less likely to be in evidence with steady or slowly changing fields and high concentrations. Even so, large electric fields can arise, as in the necking off of a linear pinch.

Assuming an output of 10^{10} neutrons per pulse (or per second for a continuous device) as the minimum for a useful diagnostic reactor, the fusion energy output is about 0·01 Joules. Guessing the power necessary to produce such a number of reactions, with the present known techniques as 1 MJ, the energy efficiency of such a diagnostic fusion reactor would be 10^{-8}. An indication of the great difficulty of the subject can be seen in the fact that the labours of several hundred scientists, in the U.S.A. and the U.S.S.R. over the last ten years, supplemented during the last five years by about a similar number in the United Kingdom, Sweden, France, and Germany, have not yet led, as judged by the publications, to achieving a really adequate diagnostic fusion reactor.

Perhaps the existing published device which comes into the category of a useful diagnostic reactor is the two-stage magnetic compression system at Livermore[2] already mentioned. Various single-stage devices, such as " Scylla,"[3] from the Los Alamos Scientific Laboratories, Kolb's equipment in Washington and similar machines at the Atomic Weapons Research Establishment (A.W.R.E.), Aldermaston, and at the Naval Research Laboratory, Washington, may possibly also be considered as at least nearly coming into the class of useful diagnostic reactors. In all these devices it has been shown experimentally that a high temperature and the emission of neutrons is associated with a reversed trapped magnetic field in the plasma. This phenomenon may prove important for further investigations.

If all the neutrons from " Zeta," about 10^6 per pulse, had been of thermal origin—which they were not—its fusion efficiency would have been less than 10^{-12}. The actual efficiency of the Livermore two-stage device is about 10^{-14}.

The second step can be considered the construction of an improved device which would act as a convenient source of neutrons of at least equal efficiency to that of the best

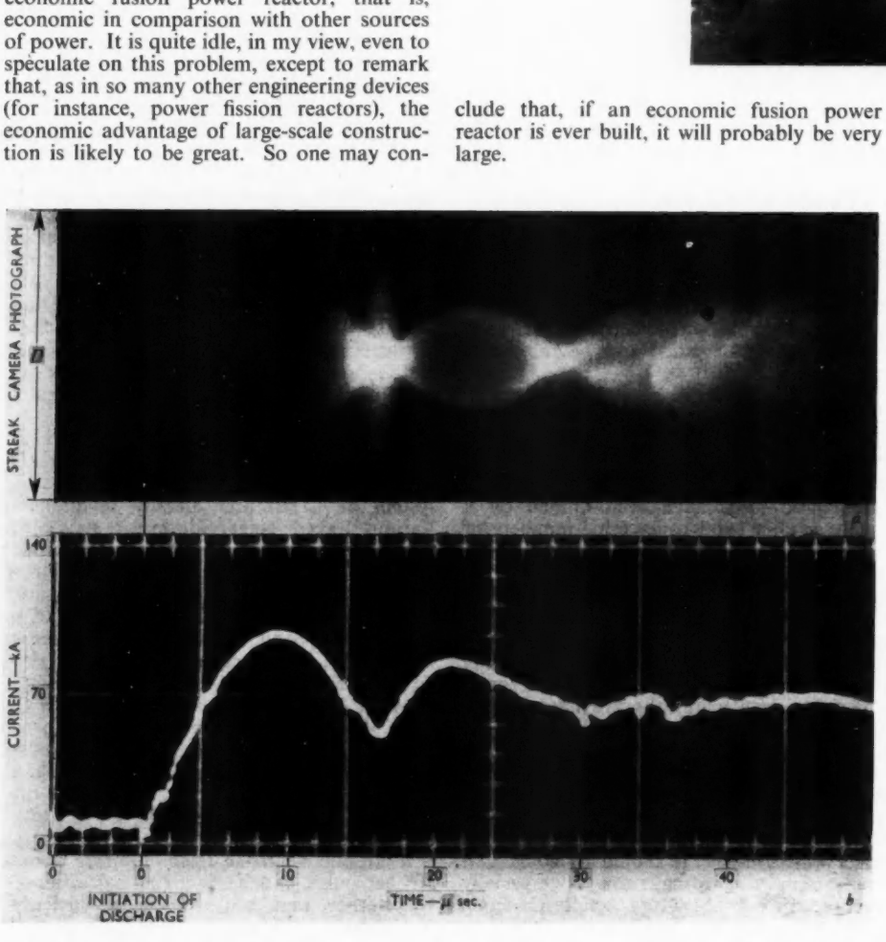
obtainable by the direct acceleration of *D* or *T* ions by an electrostatic machine, that is, greater than about 10^{-2}. For such a *neutron source fusion reactor*, an efficiency of 10^{-2} might be aimed at, giving 10^{16} neutrons per second for, say, 1MW of input power. Even the achievement of this would mean an improvement of efficiency of 10^{12} over the best existing diagnostic fusion reactor. Moreover, as a source of neutrons it is likely for nearly all purposes to be inferior to a conventional fission reactor.

The third step is the construction at any economic cost of a non-economic fusion reactor, which implies an efficiency greater than unity and so an increase of efficiency of 10^{8} over the assumed diagnostic reactor and of 100 over the assumed neutron source fusion reactor. It is quite impossible to be sure what such a power reactor might be like and how large it would be. Our present knowledge is quite inadequate to make more than rough sketch plans of possible designs as Post has done : it is highly probable that the advance of basic knowledge of plasma physics may change drastically our present ideas of what a fusion power reactor might be like—or even prove that it is not possible on a reasonable earthly scale. It must be emphasised again that increase of linear scale is likely to ease the technical problem of getting a favourable power balance for several reasons.

If and when such a non-economic fusion power reactor has been made, there is still the fourth step to be taken, that of making an economic fusion power reactor, that is, economic in comparison with other sources of power. It is quite idle, in my view, even to speculate on this problem, except to remark that, as in so many other engineering devices (for instance, power fission reactors), the economic advantage of large-scale construction is likely to be great. So one may conclude that, if an economic fusion power reactor is ever built, it will probably be very large.

A 5000V condenser bank with 0·25 MJ stored energy is arranged around three sides of a square with discharge tube 50cm by 15cm in the middle. The return lead is a copper gauze surrounding the tube. Currents up to 0·5MA are obtainable for the order of 50μsec.

Fig. 2 — Experimental equipment in Physics Department, Imperial College



(*a*) Shows the variation with time of the width of a linear discharge in argon at 0·3mm, with a condenser of 2000μF at 2·5kV giving a maximum current at 100kA. The initial " snow-plough " collapse to a very narrow pinch at 16μsec is visible, followed by an expansion, and then contraction to a second pinch, after which the discharge becomes unstable. The vertical streaks of light are due to photo-ionisation of the residual gas by the intense radiation at the instant of maximum pitch.
(*b*) Shows the corresponding current trace. The strong interaction between plasma and external circuit is shown by the sharp minimum in the current at the first pinch, due to the rapid increase of the self-inductance resulting from the rapid reduction of the diameter of the pinch. About 1000 joules of energy is transferred from the circuit to the plasma and back to the circuit in some 20μsec.
Length of tube : 45m. Diameter : 16m. External inductance : 150mμH.

Fig. 1—Interchange of energy between dynamic pinch and external circuit, $\beta \sim 1$

If we now turn from this crystal-gazing to the practical problem of planning a rational research programme, it is as well, in my view, to forget about all the four hypothetical steps outlined above, except perhaps the first, the diagnostic reactor, and concentrate on learning a great deal more about the fundamental physics of plasmas. The initial attempt, a decade ago, to make big machines such as " Zeta," " Stellerator,"[4] " Colombus,"[4] " Ogra," &c., which might take us in one step a long way towards a power-producing reactor, has failed. It was a worthwhile exercise—the analogous gamble on the first fission reactor succeeded. But having failed, I believe that what is now required is several years of energetic investigations of plasma physics, combined with inventive ingenuity, mostly on a relatively modest material scale.

Quite tricky tactical problems emerge at once : how much to rely on theory and how much on experiment. How large in size should the experimental equipment be? The case for large experimental equipment is, of course, that with such complex phenomena involving macroscopic parameters, such as temperature, pressure, linear scale, and shape, as well as atomic phenomena, such as nuclear cross sections and mean free paths, not to mention the oscillation and instabilities of a plasma, the whole device is not accurately scalable, though certain selected related properties can often be usefully scaled. On the one hand, large equipment means slow experimentation, because of the time to change the set-up, and for a given amount of money fewer separate lines of investigation. On the other hand, too small equipment may make any useful scaling-up difficult.

Experience of recent years has shown clearly the value of the moderate-sized apparatus, with a capital cost of £50,000 or so and a team of half a dozen physicists and engineers. Many of the smaller experiments

now in progress at Harwell and the A.W.R.E. are of this order of size, as are some in university departments such as at Imperial College and the University of Liverpool, or in academic institutes at Munich, Aachen, and Stockholm.

In my view the subject is still wide open for novel ideas and for new experimental discovery. It is salutary to have been recently reminded by D. Gabor how little in the whole field of plasma physics has been predicted and how much has been discovered experimentally[5]. It took thirty years for an explanation of Langmuir's paradox of the near Maxwell distribution of the electrons near the walls of a low-pressure plasma to be found, and even to-day a complete understanding of the cavity magnetron is lacking. These two examples, given by Gabor, are especially relevant to fusion research, because they emphasise the innate propensity of both streams of electrons and of plasmas to oscillate, and such oscillations are undoubtedly the origin of much of the unexpected high energy loss of plasmas which prevents the expected temperature being reached. In some cases, the slower oscillations may possibly be turned to useful purposes, for instance, the interaction of the radial oscillation of a plasma producing fusion energy with the electric circuit producing the containing magnetic field, could be used to give direct production of electric power, without use of a thermal cycle (Fig. 1).

One clearly profitable field of experimentation is to attempt to combine the use in one apparatus of more than one of the standard methods of confinement and of heating, so giving, for instance, multi-stage magnetic compression, as in the Livermore device described, or by combination of self-pinching and external pinching, or by injection into a magnetic bottle of already hot plasma produced by some other process, &c. Such complexities are bound to arise, but at the outset it is worth remembering the dictum of an American engineer, Brobeck, working in this field : " In comparing two alternative proposals, neither of which will work, the simpler is to be preferred."

As to the best role of theoretical investigations to aid progress towards the goal of controlled fusion reaction, I am ill-qualified to speak, but nevertheless will venture some observations. If it should turn out that there is a solution to our problems which involves only simple geometrical shapes and essentially linear interactions between the main parameters, then clearly very valuable design studies can be done using fast computing machines. If, however, it becomes evident that the devices must have unsimple geometry and that some of the essential phenomena are non-linear in character, then it seems unclear whether even the fastest available machines will give the required results at an economic cost in time and money ; until, that is, the main essential phenomena have been studied experimentally in a rough quantitative way. When this has been done, then clearly there will be a large amount of theoretical computing to understand more fully the details and to assist towards optimising design parameters. A related question is this : if it happens that a successful device will depend on some novel physical effect, is it likely that this new effect will be first identified experimentally or theoretically? I think the history of discharge and plasma physics makes the former more likely. If this is so, then clearly a great amount of experimental work is needed over a wide front. Every suggestion from theory about a useful experiment to perform should be followed up. Conversely, however, few theoretical predictions that nothing useful is likely to be observed in some simple and naively plausible experiment should prevent the experimenter having a look to see : the unexpected stability of the plasma in the double compression mirror machine is a case in point.

In my view there is a big role for experimentation with moderate sized and rather slow devices designed explicitly to make easy observations of the complex phenomena of the formation, stability and eventual break-up of different forms of plasmas. The experimental tube, often filled with a heavy gas like argon to slow down the motions so as to make them more easily measurable, becomes in effect an analogue computer suitable for the discovery and study of new plasma phenomena. Much of the work of the group at Imperial College under Dr. Latham has this character and has already borne fruit in the experimental discovery of the initial break-up of radially accelerated plasmas by the purely dynamical Rayleigh-Taylor mechanism. Fig. 2 shows the general arrangement of conductor bank and discharge tube, and Fig. 1, shows the progress of a dynamic linear pinch and the electrical interaction between the pinch and the electric circuit.

In all such experimentation it may be useful to recall a dictum of a great discoverer, the physicist Frederick Joliot : " Certainly one must start from a preconceived idea, but whenever possible the experiment should be designed to open as many windows as possible on what has not been foreseen." To which one might add Rutherford's advice : " Discover a phenomenon—then study it."

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Amplifier Integrator Technique for Echo Sounder

REJECTION of unwanted echoes in echo sounding by a computer technique, and depth presentation by scale and pointer, are characteristics of the " Metron " echo sounding equipment described in our February 24 issue. As then stated, discrimination between wanted and unwanted echoes is inherent in the design of the amplifier integrator employed. The following description of how this unit operates has been furnished by the maker of the " Metron " equipment, the Marconi International Marine Communication Company, Ltd.

The basic principle from which this equipment has been developed is that if a time base waveform be initiated at the instant of transmission, then the voltage of the waveform at the precise moment when an echo returns to the projector system is a function of the time interval or depth of water. This voltage is indicated by a valve voltmeter device, the scale of which is calibrated in feet or fathoms, according to the time constant of the time base waveform in use.

Immediately prior to the next transmission cycle, all essential circuits must be returned to " zero " or to a discharged condition in order to be ready to accept the new and possibly different " depth voltage " indication. It is an established fact that in any one cycle of sounding, i.e., from transmission and through the reception of all echoes originated by the transmission, the strongest echo signal is from the seabed immediately below the vessel. Fish echoes, re-echoes, etc., are of lesser amplitude and it is one of the functions of the amplifier integrator unit, while accepting all echo signals, to select only the largest one and transfer the time base voltage at that instant to the indicator meter unit for display at the end of each duty cycle.

The amplifier integrator has a number of separate output points at progressive sensitivity levels spaced several dB apart. Each output point is coupled via a d.c. amplifier to a bi-stable thermionic switch called a " discriminator switch," each of which will be operated by a different level of signal input to the receiver. Each discriminator switch can be utilised only once in a sounding period, for having been operated, it will remain so until it is automatically reset at the beginning of the next sounding cycle.

If a weak echo resulting from, say, fish, be the first to return to the receiver, this may be of sufficient strength to fire the most sensitive switch, so that this switch is put out of action. Therefore, only the reception of a subsequent, more powerful echo, can fire further and less sensitive switches which likewise would then be put out of action. As the strongest echo in a sounding period is always that from the ocean bed (re-echoes are obviously weaker) it will be seen that this is the last signal in the cycle to have effect.

On the reception of a depth signal and the consequent firing of a discriminator switch, a charging capacitor is charged through a diode to the time base voltage existing at that moment. Due to the blocking action of the diode the voltage will remain unchanged until the end of the sounding period, unless a subsequent stronger signal is received. Should a stronger signal be received, it would fire more of the less sensitive discriminator switches, causing the charging capacitor to be charged to an even higher level, due to the still rising time base voltage. No subsequent weaker signal in a sounding period can fire any of the remaining switches. The final level to which the capacitor becomes charged is proportional to the true depth.

Non-Chemical Photocopying Process

As a result of an extensive programme of research undertaken jointly by Copycat, Ltd., 40, Victoria Street, London, S.W.1, and Ets. Bauchet et Cie in France, the two firms have announced an important advance in diazo photocopying technique. The " Diazotherm " method, as it is called, does away with the need for any chemical, whether liquid or vapour, for developing or otherwise treating the exposed copying paper. This, it is stated, has been achieved by incorporating sensitive coatings of an entirely new formula and making certain changes in the coating process. After exposure in the conventional way, the paper merely undergoes a simple heat-treatment. It is claimed that all the present advantages of the " dyeline " process are retained without any increase in running costs. Installation of equipment is simplified, as all that is needed is an electric point.

[Reply Card No. E3732]

LETTERS AND LITERATURE

Letters to the Editor

RAILWAY CONVERSION

SIR,—From a study of Brigadier Lloyd's map on page 208 of your issue of February 10, 1961, I note that Waterloo station is evidently on his list for conversion. May I therefore put another problem to him?

In the evening period from 4.45 p.m. till 6.30 p.m. under previous discussion, in addition to thirteen long-distance trains leaving during this time there are eighty-six suburban trains, all very heavily loaded and carrying on an average 600 passengers apiece. Some have very nearly 1000 on board. Seeing that the rolling stock for conveying this multitude would have to be brought into the terminus I do not see that one could allocate more than three of the six traffic lanes to outgoing traffic. On the other hand, Brigadier Lloyd may have thought of a way round this one.

One other small point: how would the traffic be dealt with while the conversion work was in progress?

O. S. NOCK

20, Sion Hill,
Bath,
February 15, 1961.

SIR,—As I recently had the honour of an invitation to attend a local meeting of the Railway Conversion League and having duly thanked my hosts, I would like to make the following public comment:—

I find that we are expected to believe that a 24ft/30ft carriageway,

1. with two opposing traffic lanes
2. and perhaps a third in the middle
3. with vehicles at 60 m.p.h. steady speed
4. and 40ft/60ft vehicles
5. no traffic control system (? junctions)
6. no time schedule, or a basic minimum to schedule only
7. overtaking vehicles
8. other "approved" vehicles and drivers allowed to enter and leave the system as they please
9. headlights would be needed for guidance (the unsolved dazzle problem again)
10. long stretches of exposed embankment
11. on a wild wet windy winter night!

is a desirable alternative to the present system now being modernised. I admit that I have taken the worst conditions, perhaps excepting ice on the surface, but they would occur. Item 3 is impossible everywhere always, item 6 would cause utter confusion, item 8 is uncontrollably dangerous.

This is apart from such matters as the need to find thousands of vehicle crews, presumably from the ranks of unwanted signalmen as the present railwaymen would more or less be doing parallel jobs, also increased power needed owing to much higher rolling resistance, total permanent dependence on imported fuel, &c. All this plus the arithmetic which "proves" that 25,000 goods vehicles could replace 1,124,000 (a present "use efficiency" of 2·2 per cent is to be supposed!) and the tortuous logic of finding a common basis for accidents, &c., and I think that one may be permitted to doubt the wisdom of a grandiose scheme of conversion.

Surely the general principle of rail guided traffic for dense and heavy traffic is not lightly to be thrown aside, and the effort should be to integrate our two systems to get the best out of both, preferably free from party politics and with each bearing the costs on the same basis, although the latter is difficult with the roads as the transport vehicles do not have sole use of the route. I do not think it should be impossible to do this, without the colossal cost of conversion. The example of France shows that railways can be highly efficient, alongside a first class system of trunk roads.

Finally, I am neither a railway nor road engineer.

C. G. DAHL

Guildford,
February 13, 1961.

MILLIONS TO BE SAVED?

SIR,—I do not want to appear discourteous to Mr. Harding, or to side-step any important points of his argument, but in view of limited space I must confine myself to one or two issues not already covered in the publications of the Railway Conversion League or in the previous correspondence in THE ENGINEER, now published as a separate volume.

The League believes that we should aim at the highest possible standards in the public passenger transport services on the converted railway system, and that these will be attractive enough to draw back many travellers, particularly commuters, who use private transport now for many journeys simply because of the appalling conditions met with in public passenger services at the present time. Since the capacity of roads, under conditions of free flow, is so much greater than that of railways there will be vast reserves of capacity on the converted routes, over and above the needs of passenger and goods services. This will be available to "cream off" much of the private passenger traffic from the ordinary road system. These are not "airy-fairy" claims; they are facts based on practical working experience under comparable conditions.

I am sorry, but not surprised, that none of your correspondents have taken up my challenge to show alternative solutions of the traffic crisis, other than railway conversion. Mr. Harding says, "My own view is that the development of road and rail should proceed side by side as rapidly as possible, uneconomic sections of railway being converted to roads as they become available." This is, apparently, as near as we get to a suggested alternative. However, the Government has spent over £700 million of taxpayers' money on capital investment in the railways during the past six years, which has failed to render the railways financially viable as predicted and it would thus seem that at least the railway half of Mr. Harding's proposed development policy has been tried and found wanting. It seems doubtful whether adequate spending on the roads during the same period would have helped the railways towards achieving that parity which is so much desired by those who advocate "the best of both worlds."

The basis of Mr. Harding's suggestion, as indeed of present Government policy, seems to be a simple belief that somewhere in the railway system is a hard core of solidly profitable transport business. The only trouble is that nobody seems to be able to put their finger on this elusive gold mine. Failure to locate it might be due to the defects of the railway accounting system, to which attention was drawn in the recent report of the Select Committee on Estimates. On the other hand, looking at the pronouncements of staunch Government supporters of the gold mine theory one can hardly avoid the conclusion that it is really only to be found where the rainbow ends. Branch lines have never been claimed as the possible gold mine, so we can safely dismiss them. Main lines? I quote Mr. John Hay, House of Commons, October 26, 1960: "It is quite clear, says the Select Committee, that long-distance passenger lines cover only their costs and their overheads; they do not contribute to the central charges of the Commission." Commuter traffic? Mr. Hay again, in the same debate: "The commuter services themselves, where traffic is at its height and the utilisation of the equipment is at its most intense, still, apparently, do not pay." Sir Richard Nugent, in the same debate: "It is an astonishing state of affairs, when the primary role of the railways to-day is to carry passenger traffic, particularly commuters, that the main loss should be on passenger traffic." Freight? Mr. Watkinson (then Minister of Transport), House of Commons, December 11, 1958: "It is on the freight side that the position is so different and, quite frankly, so very difficult." Has the freight side improved since then? It has. Ton-miles by rail are up by between 2 and 3 per cent, the net result of which must mean a small but inadequate contribution to the additional interest charges incurred in the meantime on a further £300 million "shot" of "modernisation." As a solution of the "very difficult position" such a result is negative.

Mr. Harding's view of the matter therefore appears scarcely likely to provide an answer to our problems; but if he is prepared to stand by his advocacy of "uneconomic sections of railway being converted to roads" then the evidence quoted above shows that the Railway Conversion League is merely being realistic about the ultimate end of what he is advocating. If Mr. Harding and those who see eye to eye with him deny this, then there is an obligation on them to show evidence of the existence of "economic" sections of the railway system which should

be retained : evidence which the B.T.C., the Ministry of Transport and the Select Committee on Estimates have all failed to produce.

Perhaps, however, there are other more promising alternatives to railway conversion. Now would seem to be the time to bring them forward for examination.

M. J. DOUGLASS

Railway Conversion League,
Guildford,
February 18, 1961.

SIR,—The Southern Region of British Railways will serve to exemplify some of the passenger traffic problems raised in recent letters. The necessary facts and figures were given by Mr. P. A. White, traffic manager, S.E. Division, B.R., in an address to the Institute of Transport on January 11, 1960, reported in the Journal of the Institute for March, 1960, under the title, "The Problem of the Peak"; the report does not, in my opinion, fully reflect the urgency accorded to the problem during the actual address and subsequent discussion—but that is the way with reports on uncomfortable matters. Discomfort, for the S.R. commuters, on an ever increasing scale, was indeed the keynote of Mr. White's address; he revealed that the S.R. tracks running into London were already being worked to their maximum capacity, and accordingly the number of business trains could never be increased significantly, not even to tie in with the Kent coast electrification schemes; but the population of the region would increase by 650,000 in the next ten to fifteen years, adding perhaps 100,000 to the number of daily travellers to London by rail; the Kent trains were already the most overcrowded of all, yet perhaps half of the total increase would occur in that county alone. "Discomfort is no deterrent," said Mr. White regretfully; his solution was to build more railways, unless London could meanwhile arrive at "a new design for living."

It transpires, from Mr. White's statistics, that the seven S.R. London terminals deal with up to 417,000 passenger arrivals a day : the morning accounts for 304,000 of them, the remainder of the day 113,000; the heaviest hour sees an inflow of 181,000.

As was shown in the sketch map in your issue of February 10, the S.R. routes comprise a minimum of twenty-six rail tracks as they converge on Central London. Were these routes paved, and then marked in lanes of full rail track width (which is unnecessarily wide for a road traffic lane), their total capacity (at the moderate flow of 1000 vehicles per hour per lane) would be 13,000 v.p.h. each way. Accordingly, they could, if necessary, pass in a single hour 520,000 passengers in forty-seater buses in either direction. Suppose this bus service were laid on for the morning peak hour, and the number of incoming passengers remained at the present figure of 181,000, there would be an average of twenty-six empty seats in each bus! There lies the additional capacity (and comfort) which the growing population of the southern region requires. Whence can it materialise otherwise? The question presses.

The previous paragraph is to be taken, please, as no more than an illustration of the waste in route capacity when the vehicles are railway trains, even when they are mainly electric trains operating under the highest standards of efficiency known in the railway world; only free-running motor vehicles can fully exploit the capacity of a route; in the form of buses they could give any known railway route, converted into a road, a passenger carrying capacity far in excess of the demand upon it. The spare capacity would, of course, be available for private and commercial vehicles : but sufficient particulars of that sort to make a complete picture of my subdued illustration have already figured in this correspondence; and I seem to be under some obligation to refer to the headway between successive vehicles.

Briefly, if railwaymen will mentally translate their customary minutes of headway between trains into seconds of headway between motor vehicles they will be entering the realm of realities. Mr. N. Pallett seems worried about a bus headway of 7½ seconds on Borough Market Bridge—reputedly B.R.'s busiest spot. But that is only 480 v.p.h., whereas the American design figure is 1500 v.p.h. (headway 2·4 seconds) which still permits of considerable overload for short periods. Unfortunately, for purposes of comparison, the precise capacity of single rail track is undefinable : too many local factors are involved. When Mr. White was asked to state the proven capacity of his busiest pair of rails he could not be specific, though he referred to Borough Market much as Mr. Pallett did. There is, however, a valuable piece of information on track capacity in B.T.C.'s 1959 Report, which will be of particular interest to Mr. E. J. R. Kay, for it deals with the four-tracking of the Metropolitan line between Harrow-on-the-Hill and Watford South Junction mentioned in his letter dated February 15. The passage reads, "When this scheme is completed in 1962 the service in the evening peak hour will provide 9800 seats per hour north of Harrow-on-the-Hill instead of 7800." Against that, I repeat, one bus lane could readily dispense 40,000 seats per hour.

T. I. LLOYD

Guildford,
March 4, 1961.

SOME RAILWAY QUERIES

SIR,—On belatedly reading THE ENGINEER for November 4, 1960, there are a few points which occur to me.

1. On page 744 you mention ". . . 800 miles or so of single line." Surely this is too low; would not 8000 be correct?

2. On page 745 ". . . might not the Glasgow suburban lines have been electrified on the third-rail d.c. system. . . ." They might, but infant mortality would probably have exceeded the recent foxhound incidents in Kent. Perhaps you do not know Barlanark or Haghill or other Glasgow Corporation housing estates near to the Airdrie line. If the shortest route to a public service vehicle is across the track that route will be used; fences will be wrecked almost as soon as they are repaired or replaced, any child can wander on the line, the older children use it as a playground. So this may have been one factor which influenced those who planned.

3. On page 763 the map shows a track sectioning cabin at Dalmuir. It is my opinion, based on observation from the adjacent public park, that the size of the building and the equipment installed outside it make it a feeder station.

4. The map also shows proposed electrification stopping at Greenock Central. Surely it will go on to Gourock!

C. W. SEX

Kingston-on-Thames,
Surrey,
February 19, 1961.

[Query 1. Our correspondent is right, a nought is missing. The actual figure given in the B.T.C. Annual Report for 1959 published June 30, 1960, is 6478 route miles, more than half of which is in Wales and Scotland.

Query 2. Interesting!

Query 3. The map is correct.

Query 4. No final decision has been taken about the terminal points for electrification.—ED. THE E.]

NATIONAL WATER GRID

SIR,—I appreciate your continuing interest in water conservation and recent references to the principle of a water grid.

With regard to the point raised by Mr. F. Newhouse in his letter in your issue of February 17, there is, of course, no suggestion of water flowing along the Grand Contour Canal without a surface gradient to impel it. After the level has fallen the amount allowable, say 1ft, it will be necessary to have a low-lift pumping installation to restore the level that 1ft. Such installations should work equally well in either direction as a plural functioned grid would require, and should be spaced at round about 12 miles along the canal so as to deliver 2000 cusecs within an average velocity of 1 mile an hour, so as not appreciably to affect navigation.

J. F. POWNALL

Cardiff,
February 25, 1961.

Book Reviews

Radio Aids to Civil Aviation. Edited by R. F. HANSFORD. Heywood and Co., Ltd., Carlton House, Great Queen Street, London, W.C.2. Price 126s.

THE fourteen authors who have contributed to this work have provided a comprehensive guide to current radio and radar facilities for air transport. The book also forms in its first 130 pages a textbook on those phenomena of radio wave propagation which determine the suitability of different frequencies for the various services, and also form the basis of direction-finding and fixing systems by radio and radar. However, the fundamental radio aid is communication. Even the copybook navigator of the *Manual of Air Navigation*, 1939 edition, originated one departure signal and three position messages during his flight from Pembroke Dock to the Scillies, in the

LETTERS AND LITERATURE *(continued)*

intervals of dropping sea markers and taking compass bearings. To-day communication is essential to air traffic control and in this book is treated in a chapter of over thirty pages which deals with the allocation of frequency bands, describes typical equipment, and finally discusses the development of suitable coding for passing routine information at a high rate.

The section on *en route* aids has five contributors who cover the field from the radio compass and ground d.f. equipments to the hyperbolic systems and the purely airborne devices such as Doppler radar, map-painting radar and radio altimeters. Numerous diagrams clarify the text. The V.O.R. description, however, would be easier to follow if a drawing had been included showing typical instrument indications for various aircraft positions relative to two or three beacons.

Air traffic control is approached with a discussion of the data required at the ground centre and the present means of obtaining and collating it. The problems and advantages of secondary radar are dealt with at length, leading to an account of a proposed system of this kind, and a suggestion of how the various classes of information obtained regarding aircraft movements might most conveniently be combined into a controller's synthetic display. Subsequent chapters deal with aids to approach, landing and surface movement; weather radar; and radar links between radar sites and control centres. All sections of the book are as up to date as the rapid changes in its subject allow, and in summing up or looking ahead at the end of most chapters the likely pattern of future development is outlined. A final chapter on "Present Trends" gathers together the many strands of this complex subject. Emphasis is placed on the role of communication as a part of the navigational aid system. In this section, as indeed throughout the book, the treatment is objective, the pros and cons of rival systems which have been the subject of controversy being clearly evaluated and considered in the light of developments now in progress. Another characteristic of the book as a whole is the use of block diagrams of equipment which assist understanding of its operation and also enable the half-tone illustrations of apparatus—often necessarily of the "black box" variety—to be viewed with more interest. Circuit diagrams are wisely confined to a few special circuit arrangements so that the reader is not overburdened with detail. It would have been useful if one or two more block diagrams could have been included to show typical aircraft radio and radar installations for short, medium and long-range services.

A concluding look into the more distant future envisages the use of active "fixed" satellites for relaying u.h.f. or microwave communications traffic, and for forming the basis of a position-fixing system.

Appendices to the book include some I.C.A.O. regulations, a summary of equipment characteristics, and a glossary of useful terms. Keeping abreast with progress is becoming an increasingly fearsome task as every art develops its own vocabulary and phraseology, and the glossary is a welcome addition to a volume of reference designed for a wide readership, few of whom can be versed in all aspects of the subject with which it deals.

Marine Corrosion Handbook. By T. HOWARD ROGERS. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 97s.

IN the preface to this book the assistant naval constructor-in-chief, secretary general, Royal Canadian Naval Committee on Corrosion and Fouling, explains how the officer-in-charge, Dockyard Laboratory (Naval Research Establishment), H.M.C. Dockyard, Halifax, Nova Scotia, was assigned to write this little handbook. He describes the author in the following very pleasing manner. "Mr. Rogers' stature in the field of corrosion is distinguished, but as a person he is no less distinguished, having patience where it is due and aggression where it is needed. The value of his dynamic personality is, therefore, almost as great as the value of his contribution to our collective knowledge. No quarter deck is foreign and no commanding officer a stranger to the bearded and energetic figure of the author."

Although of only 297 pages, 8in by 6in, this new handbook will be very valuable to sea-going engineers, dockyard engineering staff, ship designers and constructors, especially in the United Kingdom, Canada and the U.S.A. The author's experience has bridged these three maritime countries because before serving in Canada he had been corrosion investigator in the British Non-Ferrous Metals Research Association, London. He has thus had access to many published and privately circulated reports on the experience of corrosion in the seagoing vessels of navies with great practical experience of marine corrosion, and the scientific means of its prevention. Moreover it should be added that the Royal Canadian Navy was the first modern navy to use cathodic protection extensively in its warships.

The subject matter of the book is divided into 118 alphabetically arranged sections, listed in the table of contents, there being no conventional division into chapters. However, it is clear that the seven pages of index and the thirteen pages of glossary at the end of the book will help readers to find the data they seek. The sections which will be most appreciated by sea-going engineers are important contributions on cathodic protection, electrolytic derusting, and welding. They are based on recent experience, deliberate observation, and measurement.

The thirty-five figures are well chosen and together with line diagrams and tables clearly illustrate the phenomena of corrosion aboard and around ships. The Royal Canadian Navy and the author are to be congratulated on the foresight and initiative shown in this very valuable and convenient handbook. It may safely be recommended to any engineering library.

Principles and Practice of Aircraft Electrical Engineering. By H. ZEFFERT. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 90s.

THIS is, in a nutshell, an astonishingly good book. Although the author is unusually well qualified to write on aircraft electrical problems, the success of the book lies in its thoroughness and completeness, qualities which must have resulted from a strong backing by the author's firm and the assistance that an industrial background can give to an author on a complex technical subject. If the comprehensiveness and literary lucidity of the book are a credit to Mr. Zeffert, his firm must be commended for encouraging him after twenty-five years' practical experience to set on paper for the benefit of the younger or less experienced engineer, the knowledge built-up over these years: and how else can the young engineer learn in breadth if not from books? Although dealing primarily with aircraft systems there is a great deal in this book that can interest and teach any electrical engineer. The technical pace in aeronautical electrics is as great as in aeronautics itself, and the technical standards, circuits and detail design of its electrical machinery are more advanced than, and undoubtedly influence, some more conventional spheres of activity.

The book treats very thoroughly the basic features of electrical power generation and distribution by a.c. or d.c. methods in some 180 pages. No less than 500 pages follow on the detail elements or components, and their use in other systems on the aircraft, from engine starting to galley heating. Adequate treatment is given to such matters as terminal ends, instruments and instrument lighting, gyros, batteries, relays and so on. An excellent coverage is given of modern radio and radar systems, treated from the aircraft user or operator's point of view without discussing the detail design and circuitry of the equipments themselves.

At ninety shillings, this book is probably beyond the pocket of the normal student: but it certainly should not be felt to be too expensive for the electrical design or development engineer in any industry who is interested in knowing in detail what "goes on" in the modern highly complex and extensive aircraft electrical system. What some enterprising book publisher or distributor might consider doing would be to set up a distribution system run by the chief draughtsman in suitable firms, where books of this kind could be sold to young engineers at five shillings a week. Or let it be done through a local bookseller, who is prepared to make it attractive to the firm's management by dividing the discount.

Doublet D'Hélices Coaxiales, Hélice Unique. By JEAN CRISTESCU. Publications Scientifiques et Techniques du Ministère de l'Air, No. 356. Paris: Magasin C.T.O.: 2, Avenue de la Porte-d'Issy, Paris (15e). Price Fr.800.

THE present work studies the methods of calculation for a pair of counter rotating coaxial airscrews, and those of a single airscrew. On the basis of the results a number of such airscrews have been tested in wind tunnel tests at the Institut Aérotechnique at Saint-Cyr-l'Ecole. The author solves the aerodynamic equations for propellers arranged singly and in tandem and then applies the solutions to some characteristic cases. The results, shown graphically, serve to compare the different approaches to a solution which have been made. These theoretical methods do not take into account interference with the fuselage, wings or other parts of the aircraft, and it is therefore of interest to carry out a comparison with wind tunnel results employing a "minimum body" fuselage.

Mathematical Tool Kit for Engineers. Second edition. By H. A. WEBB and D. E. ASHWELL. Longmans, Green and Co., Ltd., 6 and 7, Clifford Street, London, W.1. Price 15s.

THIS book is a collection of mathematical methods and techniques that have frequent use in their application to the study and practice of engineering. It is also a mathematical textbook which explains and gives the theory behind the methods in a clear and straightforward manner. It assumes a knowledge of mathematics normally possessed by the engineering degree student; it gives references to suitable books and other sources of information for those who wish to go more deeply into various aspects.

Engineers will appreciate the style the authors have adopted in explaining some of the techniques: by giving "rules" and pointing out "snags." At the same time the fundamental theory is presented by theorems which are proved with sufficient mathematical rigour to satisfy the engineer reader. They are well illustrated by worked examples, which are themselves used to build up the theory and to which subsequent references are made. Problems with answers are given at the end of each chapter.

The first edition of this book was published in 1957. It then contained chapters on the following subjects: differential equations; uses of the operator D; methods of evaluating integrals; calculus of variations; Bessel functions; and contour integration. This second enlarged edition contains additional chapters on complex numbers, Macaulay's methods, Laplace transform, and theory of errors. The mechanical and civil engineer will welcome the chapter which describes Macaulay's method of solving discontinuous particular integrals; probably the electrical engineer will find more use for the chapter on the Laplace transform; all engineers are concerned with some form of measurement and will profit from the application of the error function. By these additions a comprehensive, useful and interesting book has been produced. It is, of course, possible to suggest other topics that might have been included; but it must be remembered that the book is described as a "tool kit" and not as a "workshop." It is inexpensive and admirable for its purpose and it should find a widespread use on the engineer's bench and desk.

Der Neuzeitliche Strassenbau. By E. NEUMANN. *et al.* Springer-Verlag, Berlin–Wilmersdorf, Heidelberger Platz 3, West Germany. Price DM.66.

PROFESSOR ERWIN NEUMANN'S book *Der Neuzeitlicher Strassenbau* is an old and valued friend. The first edition of this comprehensive treatise on road construction and related topics appeared in 1927, and the second and third editions followed in 1932 and 1951. This present fourth edition reveals the growth of this subject since 1951; it contains over 600 pages of text as against some 400 pages in the 1951 edition and the "references" have been increased from 246 to 458. Most of the references are to German publications, but a sprinkling of American, British and French books and periodicals have been mentioned.

The author has been Professor at the Technische Hochschule at Stuttgart for many years, where he has both lectured and carried out research. In preparing this book he has clearly had two aims, to make it both a students' textbook and a reference handbook for practising engineers. This has involved him in the task of summarising the latest findings of researches in his subject. This has been done well as in previous editions; readers will clearly gather which topics are being actively studied in each of the fields covered and which are the research organisations carrying out the work.

The first main section deals generally with the road and the vehicle and related topics such as skidding, braking and the measurement of unevenness, then come sections devoted to layout, landscaping and earthworks. The prevailing methods of calculating the thickness of construction needed for any given set of circumstances are then summarised under the heads, purely empirical methods, empirical methods using soil classification data, semi-theoretical methods and various theoretical methods. The improvement of earth roads is then discussed, together with sections on traditional and modern methods of road construction, including very full descriptions of materials and processes. Final sections deal with aggregates and tunnelling. In the third edition Profesor Neumann received some help from specialists in road landscape design, the chemistry of bituminous materials, soil mechanics and other topics, but in the fourth edition these collaborators have prepared complete sections, a recognition that the task of writing such a book together with the duties of a University chair is taxing the powers of a single individual, however able, in view of the vastness of the subject and the rate of its development in recent years. Professor Neumann and his fellow-authors have succeeded in the difficult task of bringing out a book of this size and of including up-to-date information; some of the references are to papers published in 1959.

Most of the references are full enough to be found easily, but for a few of them a clue to the abbreviations used is needed and will be found in the list after the table of contents.

Einführung in die Strömungsmaschinen. By MAX ADOLPH. Berlin-Göttingen-Heidelberg: Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3. Price DM.24. A TEXTBOOK designed especially for the student and the young engineer, Dipl.-Ing. Adolph's *Introduction to Fluid-Kinetic Machines* opens with a full treatment of the general physical and mechanical foundations, an extensive chapter being devoted to energy transformations, blading, similarity, losses and control organs. A description of the various forms of water and steam turbines, impeller pumps and compressors, is followed by examples of representative design calculations. The book concludes with a discussion of the operation and regulation of turbines and pumps. Well illustrated and printed in accordance with this publisher's usual high standards, it will be found of interest as a synopsis of the theoretical and practical aspects of fluid-kinetic machinery, while a list of the more important German monographs is appended.

Books Received

Mechanical Waveguides. By Martin R. Redwood. Pergamon Press, Ltd., Headington Hill Hall, Oxford. Price 50s.

Silicones. Edited by S. Fordham. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 36s.

Dictionary of Electronics. By Harley Carter, George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 35s.

The Fifteen Wonders of the World. By Rene Poirier. Victor Gollancz, Ltd., 14, Henrietta Street, Covent Garden, London, W.C.2. Price 25s.

Books of Reference

Achema Jahrbuch, 1959–61. European Catalogue of Chemical Plant/Apparatus/Instruments. Edited by H. Bretschneider. Frankfurt (Main): Dechema Deutsche Gesellschaft für Chemisches Apparatewesen, Dechema-Haus, Frankfurt (Main), Rheingau-Allee 25. Price included in membership fee of 1961 Achema Congress. Free of charge to registered Congress visitors.—The *Achema Yearbook*, 1959–61 which has just been issued in two volumes, is designed as a book of reference for visitors to the Achema Chemical Engineering Exhibition and Congress, 1961, due to be held in Frankfurt-on-Main during the period June 9 to 17. Vol. I, published in German, English, French, and Spanish, outlines the nature and scope of the Exhibition-Congress and associated events, and contains brief reports on 106 research institutes in twelve European countries including the work currently carried out there, as well as progress reports from 147 makers of chemical equipment, plant and apparatus.

An account of the life of Max Buchner, founder of Dechema and of the *Achema*, who died a quarter of a century ago, will be of interest to those whose work has brought them into contact with the German chemical industry during the first three decades of the century.

The second volume which is being issued separately in each of the above-mentioned languages contains a catalogue of the exhibitors, over 1200 from fifteen countries, who will this year participate in the Achema; a classified subject index, buyers guide, list of trade names, and advertisement section.

Rules and Regulations for the Construction and Classification of Steel Ships, 1961. Lloyd's Register of Shipping, Garrett House, Manor Royal, Crawley, Sussex. Price 42s.—This set of Rules is dated 1961 following a decision that it would be more appropriate to associate the date with the year in which they will be used. The contents are set out in chapters lettered A to P, of which A, B and C refer to regulations and the remainder are concerned with construction rules. Additions and amendments promulgated in Notices 2153, 2166 and 2175, together with alterations of a minor nature are incorporated, and in chapter P, "Quality and Testing of Materials," the requirements for "Hull Structural Steel" and for "Steel for Boilers, Pressure Vessels and Welded Machinery Structures" have been completely revised. Chapter D sets out the rules for the construction of steel ships, including the tables of scantlings, &c., and a separate section for oil tankers. There are chapters dealing with pumping and fire extinguishing arrangements, while Chapters G to L refer to various forms of machinery, both steam and internal combustion engines, gearing, pressure vessels and electric propelling machinery. Electrical equipment is the subject of Chapter M and the next chapter is concerned with refrigeration matters, while the final chapter deals with the quality and testing of materials.

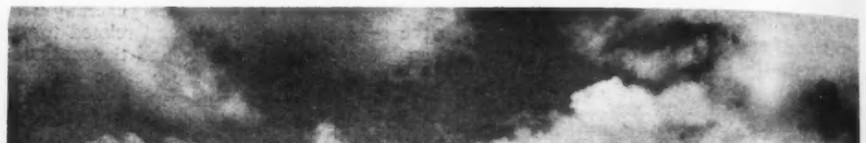
Garcke's Manual of Electricity Supply. Vol. 57, 1959–60. Edited by F. C. Garrett. Electrical Press, Ltd., 19–20, Noel Street, London, W.1. Price 84s.—The fifty-seventh edition of this useful guide to the electricity supply industry in Great Britain will, unfortunately, be the last as its publication is to cease. In format, layout and content it is unchanged and presents a general survey of the industry followed by sections giving details of the organisation and operations of the Central Electricity Generating Board, the Area Boards in England and Wales and the electricity authorities in Scotland, Ireland, the Isle of Man and the Channel Islands. Other sections cover electrical plant manufacturers and include a directory of executive personnel.

The section on the C.E.G.B. contains technical and statistical details of the Board's generating stations, listed alphabetically, with comparative tables showing operating data for each station. Similar operational details are given for the other electricity supply authorities mentioned above.

Water Power in the Province of Quebec

PART I

Of the abundant hydro-electric resources of Canada, Quebec has the richest share, both potentially and in the capacity already developed. In recent years developments have tended to be concentrated into power stations of very large capacity, served by vast catchments. Two such developments —Chute des Passes and Bersimis—are described later in this series, but examples of smaller schemes, notably at Beaumont (illustrated on the right) are also commented upon, in a general review of the three major power systems in the province.



THE Canadian Provinces of Quebec and Ontario are historically the oldest parts of Canada—" Lower " and " Upper " Canada as they used to be called—and today they contain the largest cities and the most heavily industrialised areas. Thus it is here that demands for electrical power have grown to the greatest proportions. Ontario at one time relied almost entirely on water power but has now reached substantially complete development. In Quebec the possibilities are greater, and water power has been virtually the sole source of electrical power for many years.

In both provinces the St. Lawrence River has been developed for power generation on a massive scale. We recently described the great works on that river which had then just been completed, to open the St. Lawrence Seaway and to combine with it, extensive potentialities for power generation*. The power resources of the lower part of the river, which lies within the province of Quebec are now in the hands of the Quebec Hydro-Electric Commission. This publicly controlled body supplies power chiefly to Montreal, a city of 1,500,000 population. The commission has gone far afield to the catchment of the Bersimis river, for its most recent source of power.

There are heavy industrial power demands in Quebec, notably from the production of aluminium, an industry which has become established in the province on a vast scale as a result of the exceptional water power resources, but also from other " primary " industries which take advantage of the cheap power. The Aluminum Company of Canada, Ltd., has developed the Saguenay River valley, and built a chain of hydro-electric stations there, the largest of which approach even the St. Lawrence developments in size. Another important power company is the Shawinigan Water and Power Company, which, with its subsidary companies, is responsible for power supplies over a large area of the province, and generates power mainly from the St. Maurice River.

It would be as well, at this stage, to glance at the map, (Fig. 1) to see where the power sites are. The vast size of the province should not be overlooked ; it extends over nearly 600,000 square miles and its population is just over 5,000,000. Geologically it is dominated by the Canadian Shield, an ancient formation in some ways similar to the Scottish Highlands. Thus to the north of the St. Lawrence, the whole region is upland, rising to peaks of only moderate height and with numerous lakes and river valleys scoured out by glacial erosion. The following is a description of the region written by H. M. Finlayson :

" Geologically, the Laurentian Highlands are among the oldest rock formations in the world. The rock consists of granites and two types of gneiss, one of which is of the sedimentary type while the other is of igneous origin. The formation of the rocks was followed by a lengthy period of erosion during which the land was reduced to a peneplain, or surface of low relief. This terrain subsequently was thrust upwards, allowing the streams to cut into the old surface. The streams had already dissected the peneplain, and begun to widen their courses, when another uplift provided a further opportunity for the channels to cut more deeply into the floors of their valleys. It was thus that the hills and mountains of the Laurentian Highlands were formed and, since they were carved from what originally was a nearly level plain, the higher summits all have much the same elevation. The streams, flowing in deep channels of their own creation, present ideal conditions for the development of hydro-electric power."

Thus, as in the Scottish Highlands, the heads obtainable in hydro-electric schemes are moderate, but the scale of the whole region is incomparably more vast, and the catchment serving a single power station may be comparable in order of magnitude with the whole of the Scottish Highlands. Precipitation of about 35in is well distributed and includes about 100in of snow a year, and in this type of topography, reservoir sites are common enough.

The total hydro-electric resources of Quebec are estimated to be about 11,000,000 h.p. available at ordinary minimum flow, continuously at 80 per cent efficiency. At " ordinary six-months flow " nearly twice this figure is quoted, both figures being reliable minimum possibilities. These two figures will, however, be revised substantially when the survey of water power resources which the Quebec Department of Hydro-Electric Resources is now undertaking is completed. This survey is concentrating on the remote river catchments in the James Bay and Ungava Bay watersheds, the Lake St. John watershed, and on rivers on the north shore of the lower St. Lawrence River. As for achievements up to the present, the installed turbine capacity in the province was 11,315,407 h.p. at the end of 1959 as compared with 24,888,426 h.p. (hydro-electric only) for the whole of Canada. The output of all electrical energy including secondary in 1959 was $38{,}538 \times 10^6$kWh in Quebec and $99{,}772 \times 10^6$kWh in Canada as a whole. The rate of development in Quebec has thus been very fast ; in 1958 the *per capita* production of electricity was 7600kWh per annum, the corresponding figure for the U.K. being 1880kWh though it should not be overlooked that the nature of the industries in the province accounts in large measure for this high figure.

For many years the Quebec Hydro-Electric Commission (and the companies which preceded it) relied for power virtually entirely on the Beauharnois station on the St. Lawrence. This power station was described in THE ENGINEER of July 3, 1959. Another St. Lawrence River site, which has a potential of about 1,000,000 h.p., is at Lachine rapids, right on the doorstep of Montreal. This site, however, entails impounding a wide reach of the St. Lawrence, and its construction has not yet been attempted. Instead a site was selected on the Bersimis River in virgin territory, which was so potentially rich as to be chosen even

* See THE ENGINEER, March 29 to July 17, 1959, and November 27 to December 18, 1959.

though the power generated has to be transmitted over 400 miles of high-tension lines. The Bersimis River, and the reservoir at Lake Cassé are shown on the map (Fig. 1), and the reservoir is shown in Fig. 2. The output of this scheme is from two power stations and is 2,000,000 h.p. The scheme is also conveniently complementary to Beauharnois, the latter being run-of-river and the former having generous reservoir capacity.

The Saguenay River has now been more or less fully exploited for power by "Alcan," as the Aluminium Company of Canada is called, since the war when the vast Shipshaw power station was completed, at a time when aluminium was indeed in great demand. More recent power developments have, therefore, also had to go further afield, to the Peribonka River.

Reservoirs serving the chain of stations of which Shipshaw is the largest were constructed at the same time as this station. Now, the Chute-des-Passes power station has been built to utilise part of the head between the reservoirs and the existing developments. Both Chute-des-Passes and Bersimis have underground power stations, of a size unequalled elsewhere in the world for this type of scheme, except for one other power station on the West Coast of Canada, which is also owned by Alcan†. These two are nearly as large as the St. Lawrence River stations, and are amongst the largest dozen or so hydro-electric schemes in the world.

The development of the remote Bersimis River for public supply has been something of a precedent, and the Commission has started to build another major scheme on the Manicougan River. These developments are likely to be followed by exploitation of even more remote sites, for instance on rivers draining northwards to the Hudson Bay. One such site in Labrador—Hamilton Falls—should be mentioned, even though it is really outside the scope of this article, for it has been described in the *Proceedings of the Institution of Civil Engineers*‡. Here, 6,000,000 h.p. is available continuously, with perhaps a further million in the lower tributaries of the river. This is the scale on which hydro-electric generation is possible on these remote northern rivers. The facts that such overwhelmingly favourable sites have already been discovered in these regions, and that long distance transmission of power at high voltages is practicable and not unduly costly, sufficiently explain the attention being given to the remote rivers in the provincial Government's present hydrological survey.

At present hydro-electric development in Quebec can be briefly summed up as follows. The Quebec Hydro-Electric Commission installed the final sets in the Bersimis II station to complete it by October, 1960; there are five 171,000 h.p. sets in this station. The final extension of Beauharnois power station is proceeding at a rate of installing one 73,700 h.p. set every two and a half months, and the ultimate capacity of 2,234,700 h.p. will be reached this year. And development of yet another site, known as Carillon and situated on the Ottawa River about 50 miles from Montreal, was begun in 1959 by the Commission. When this development is complete, it will have twelve 60,000 h.p. sets (and space for two more if required) operating under a head of 61ft. The Manicougan development, referred to above, envisages three stages of development, with a total capacity of more than 2500MW. The upper stage involves a multiple arch dam 650ft high, according to preliminary plans, forming a reservoir of 114 million acre feet capacity, and linked with a power station of 1100MW capacity. Development of the Outardes River is also envisaged in two stages totalling about 1000MW.

Turning now to industrial developments, the great Chute-des-Passes power station was completed in February, 1960, but work was in progress in the summer on a major diversion of water to increase the yield of power. There were two further developments in the province in the 1959-60 period, but both on a far smaller scale than those just mentioned. The Quebec Cartier Mining Company installed three 22,000 h.p. sets at a site on the Hart Jaune River on the headwaters of the Manicougan River, and two 25,000 h.p. sets were installed by the James MacLaren Company, Ltd., at Dufferin Falls on the Lievre River.

Fig. 1—The province of Quebec, showing the principal rivers and power sites discussed in the text

The St. Maurice River

The valley of the St. Maurice River is scenically one of the most attractive regions of Quebec. Great stretches of the river banks are wooded, and the hills and skyline remind one of the Scottish Highlands, though even here, in a valley compact by Canadian standards, the scale is much greater. The economic growth of the valley is typical of this part of Quebec, where the abundance of water power has been the mainspring of economic development.

The city of Shawinigan is typical in that it has grown rapidly around the two local resources which are available in abundance—water power and timber. The river is used for logging on a large scale, 40,000,000 to 50,000,000 logs being floated down in a season, and all the dams have log chutes. At Shawinigan industrial developments are on an appreciable scale and include pulp and paper works, chemical works, a carbide plant, and aluminium refining.

The Shawinigan Water and Power Company has been active in developing the river since the beginning of the century. Its main interest is power supply, and with its subsidiaries, the Quebec Power Company, and Southern Canada Power Company, Ltd., it supplies power to an area of about 31,000 square miles stretching along both banks of the St. Lawrence as far as the Ontario boundary, excluding metropolitan Montreal but including the city of Quebec. But the Company's interests do not end there and important subsidiary companies are concerned with electro-chemical manufacture, and other aspects of the electrical power industry. One company in the group, the Shawinigan Engineering Company, Ltd., is responsible for the design and construction, on a direct labour basis, of the parent company's power schemes on the St. Maurice River, and also designs and constructs other large hydro-electric developments throughout the world.

The first of the company's power stations at Shawinigan Falls first delivered power in 1903, when two 4500kW sets were brought into use. Now, seven sites stretched out along the river have an installed capacity of about 1500MW, and in addition reservoirs have been created at the headwaters of the main streams. There remain three further sites as yet undeveloped, with a potential capacity of about 300MW.

The seasonal reservoirs which are shown on the map, Fig. 3, were formed by relatively simple dams of modest size, yet their storage capacity is large, and in consequence, regulation of flow is very good. Gouin reservoir alone has a capacity of about

† The Kemano station, see THE ENGINEER, May 29 and June 5, 1953, and March 26, 1954.

‡ Hamilton Falls Hydro-Electric Scheme, Paper No. 6295, by E. N. Webb, *Proceedings I.C.E.*, Vol. II, November, 1958, pages 313–332.

7,000,000 acre feet and extends over a distance of 88 river miles. A diversion of 13×10^9 cubic feet of water annually across the watershed from the neighbouring Megiscane River is made into Gouin reservoir; the Megiscane drains into the Hudson Bay. The "firm" flow of the St. Maurice River has been increased from 5800 to 22,000 cusecs at Shawinigan Falls by the regulation which the reservoirs give. Weekly storage is maintained at Rapide Blanc for the upper group of stations, and at Grand Mere for the lower group. "Logging" dams made by the timber companies are also utilised from time to time, as occasion permits, mainly to impound the spring flood, the main reservoirs being operated purely for power generation and not for flood control.

The principal data for the reservoirs and power stations of the system are listed in Table I. It will be seen that the power stations have heads varying in the range

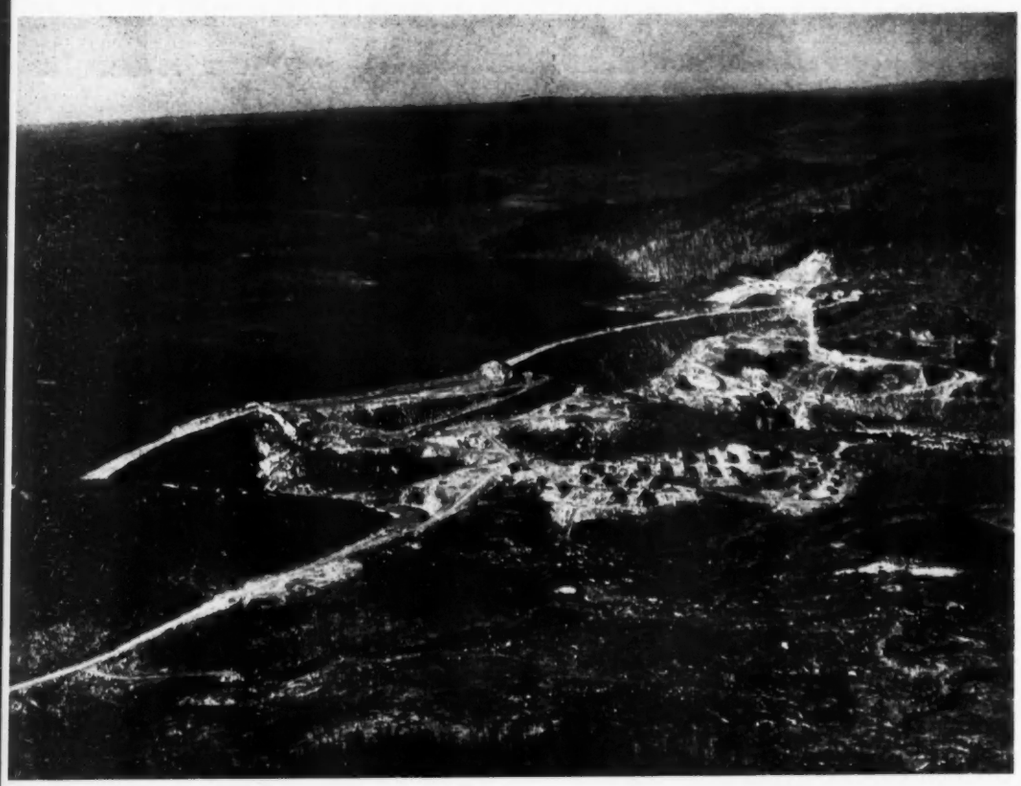


Fig. 2—The two rockfill dams forming Lake Cassé reservoir on the Bersimis River. The reservoir extends over 300 square miles. The huts to the right are a construction camp, now dismantled

60ft to 160ft, Generally, they utilise favourable sites and are of compact yet conventional layout. The constructional sequence from the earliest station at Shawinigan Falls to the one most recently completed in the chain at Rapide Beaumont affords an interesting commentary on the evolution of hydro-electric practice.

The "A" station at Shawinigan Falls was dismantled in 1951; its capacity was 43·6MW. To-day, the water available is utilised more efficiently in the "B" and "C" stations. The earlier sets in the "B" station—five of them—are horizontal-shaft, Francis-turbine-driven sets. There are three 48·5MW sets in the "C" power station. A recent addition to the company's facilities at Shawinigan Falls is a system operating office, which is comprehensively equipped with communication, and load dispatching equipment to the whole network. Fig. 4 gives a good general view of Shawinigan Falls, showing the "C" station on the right, and on the extreme right, water spilling over the Falls. Note the log chute to the left of the "C station.

The company's output of electrical energy has, as can be seen, grown steadily for the past half century. In 1959, the number of units sold was 12,028,000,000. Of this total, 70 per cent was generated from the St. Maurice River plants. With a full year's output from Beaumont, the mean annual output of the stations listed in Table I, is estimated at $8·9 \times 10^9$ kWh, and with the last three sites fully developed an ultimate annual output of $10·5 \times 10^9$ kWh is envisaged from the river in the mean year, with a maximum firm power output of 1817MW. Total generating capacity of the company and its subsidiaries is 1605MW. There is also exchange of power with the Quebec Hydro Electric Commission and the Saguenay Power Company.

Consumption of power is typical of the region. Only about 13 per cent of the total is directly consumed in the distribution system. About 23 per cent is sold to other "utilities most of which is resold by them to their own "distribution" customers. The total for distribution is, therefore, nearly 35 per cent. But the bulk of the power goes direct to industry—38 per cent to the pulp and paper industry, 21 per cent to electro-chemical and metallurgical undertakings, and 3 per cent to the asbestos industry (about 2 per cent is listed as "miscellaneous"). The industrial percentages include their proportion of secondary power (e.g., pulp and paper gets about 80 per cent.). It is perhaps worth comment that large quantities of process steam needed by industrial consumers are raised in electric boilers or "steam generators" as they are called. There is an installation of 400MW of these "steam generators" in the system, which annually consumes up to 2,000 million kWh of secondary energy.

Transmission of power in the network is largely at 230kV, though there are extensive 115kV lines as well. Secondary transmission is at 44kV and 66kV and power is generated at the hydro-electric stations at 6·6kV, 11kV or 13·8kV, 60c/s, three phase.

Beaumont Power Scheme

The first generating set at the Beaumont station was brought into use late in 1958. The complete station has six Francis-turbine-driven generating sets, with a "semi-outdoor" power station. Although this is the first "semi-outdoor" station on the St. Maurice River, the adoption of this layout is characteristic of recent Canadian stations. The generators are housed in concrete

TABLE 1—*The St. Maurice River and its Power Developments*

Hydrology:		
Catchment area		16,350 square miles
Mean annual precipitation		35in
Distance from Gouin dam to river mouth		237 miles
Approximate total fall in this distance		1300ft
Flows at Shawinigan since 1901:		
Maximum observed flow		180,000 cusecs
Minimum observed flow		5,000 cusecs
Average observed flow		25,000 cusecs
Unregulated "firm" flow at Shawinigan Falls		5,800 cusecs
"Firm" flow with existing storage reservoirs, at Shawinigan Falls		20,000 cusecs
Mean annual diversion from Megiscane river (1954)		13×10^9 cubic feet
Flow normally maintained for power generation		22,000 cusecs
Rated flow through power stations in lower part of river		29,000 cusecs
	Useful storage capacity, cubic feet $\times 10^9$	Top water level, ft a.s.l.
Reservoirs:		
Gouin (1918 increased 1958)	300	1329
Manouan "A" (1908, rebuilt 1941)	15·0	1376
Manouan "B" (1910 rebuilt 1954)	6·6	1350
Manouan "C" (1915, rebuilt 1953)	9·5	1210
Mondonac reservoirs	4·5	1300
Mattawin (1930)	33·5	1178
Ciconcine	1·8	800
	Installed capacity, MW	Gross head, ft
Power developments:		
La Gabelle (1924)	128	60
Shawinigan Falls: "A" (1903), "B" (1911–29), "C" (1949)	311	145
Grand Mere (1928)	150	80
La Tuque (1940)*	203	114
Beaumont (1958)	246	125
Trenche (1951)	291	160
Rapide Blanc (1934)	182	112
Total	1511	—
	Installed capacity, MW	Gross head, ft
Sites not yet developed:		
Rapide des Coeurs	84	70
Rapide du Lièvre	99	83
Rapide Allard	104	87
Total	287	—

* See THE ENGINEER, July 4 and 11, 1941, for description of La Tuque power scheme.

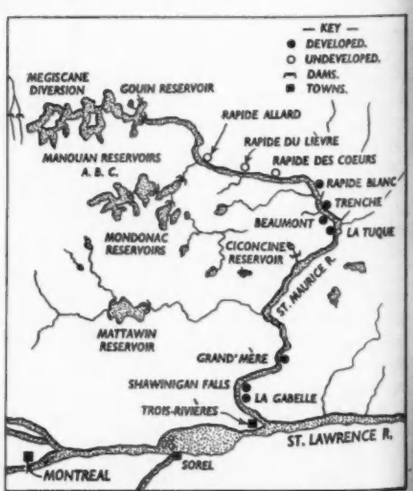


Fig. 3—Power developments on the St. Maurice River

cubicles with weatherproof hatch covers. The travelling crane can be placed over any one of them to form a weatherproof enclosure while the hatch covers are opened for maintenance. The penstocks serving the sets are 21ft in diameter and are built into the dam, and their six intakes plus a log chute, a regulating section for operational adjustments of flow, and a flood channel controlled by large sluice gates extend across substantially the full width of the river at its impounded level, a distance of 1575ft. All six sets at Beaumont were in use by the spring of 1959, but the tail-race excavation has only recently been completed.

Construction of the scheme was in many ways typical of Canadian projects of this kind. Whilst the unexpected difficulties inevitably occur (at this site an enormous "pot hole" was discovered, filled with debris, in the bedrock at formation level), the main emphasis is on "the schedule," and every effort is made to generate power after a minimum constructional period. Like the other schemes on this river, Beaumont was built by direct labour by The Shawinigan Engineering Company, this form or organisation, being, in the company's view, considered to give the best results in economy and speed of construction.

The dam at Beaumont was constructed by placing concrete from derricks, carried on steel towers, the latter being built into the permanent work. The river was diverted (in the later phase of construction) through openings left in the dam and not plugged until the rest of the constructional work had been completed. The dam is of gravity section.

Generally, 7ft lifts of concrete were placed, using a "semi-low-heat" cement, and an air entraining agent. In winter concreting was kept in progress, using steam to heat the aggregates and to cure the placed concrete, these practices being typical of contemporary Canadian practice for this class of work.

A feature of the scheme was the extensive excavation needed to deepen the tail-race, so that the full design head could be developed. A large walking dragline of 15 cubic yard bucket capacity was used for this work, and echo-sounding equipment was employed to verify the final river bed shape. This excavation increased the head from 110 to 125ft and involved removing about 2,000,000 yards of sand, gravel and boulders over a length of 12,500ft of the river.

The "regulating section" as it is termed, consists of a spillway controlled by four sluicegates, the spillway extending right down the downstream face of the dam to a pool at tail-race level at the toe. The four gates here are comparatively small and are intended for day-to-day adjustment of river flow. It was in this section of the dam that the constructional openings were left.

The regulating section is separated from the power-house by a central section, on which the log chute is constructed. The chute is a steel flume carried on columns, and it drops at a steep slope from the head pond to tail-race level. Its design had two main aims, viz minimum maintenance and economy in water usage. At the upstream face of the dam, the logs are guided by booms, and water jets are placed to help draw the logs into the entrance of the flume. Jams are avoided at the entrance due to the acceleration of the water at that point.

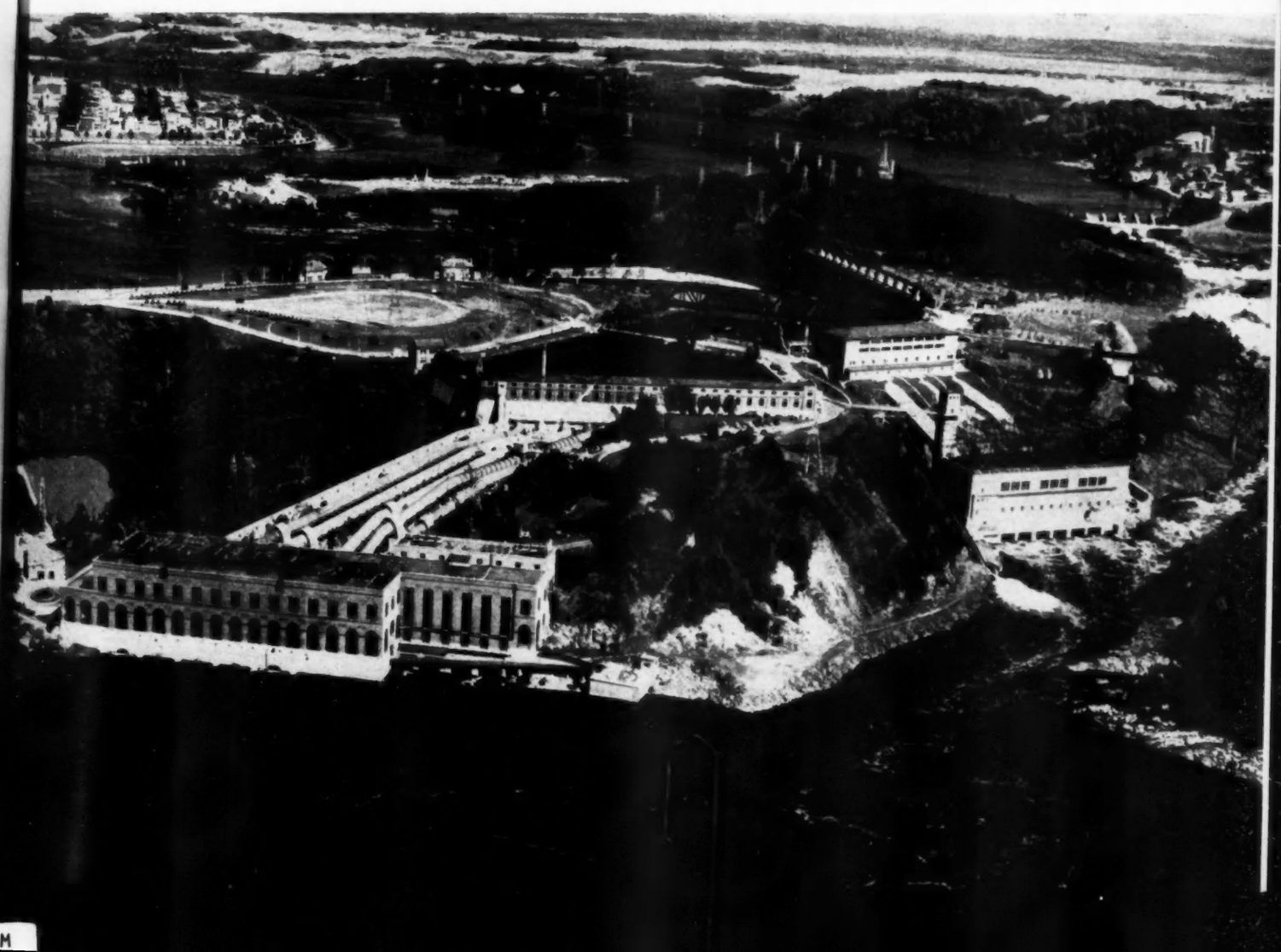
The flood spillway is on the left bank side, and is a separate channel from the regulating section described above. It is controlled by four vertical-lift sluice gates, each 32ft high by 50ft in width, of substantial steel construction. In contrast to the intake gates, which have rubber seals, these sluice gates are sealed by steel staunching rods. The gates sit on a weir from which the flood channel leads away at a moderately steep slope for about 500ft, whence a steeply sloping section rejoins the river at tail-race level. The capacity of the flood spillway is 128,000 cusecs.

The log chute, and the flood spillway both necessitated hydraulic model investigations in their design. Two problems may be cited by way of example, namely the detailing of the intake of the log flume, and the behaviour of flood spillage in the spillway channel with one of the four sluice gates opened.

Construction of the Beaumont development also called for extensive diversion of rail communications. The electrical and mechanical plant installed is noteworthy as an economical and carefully thought out installation, but calls for no special comment in the design of individual items, which are representative of modern practice in this field. Control of the six 41MW sets at Beaumont, should however, be mentioned. The site is rather remote, and a minimum requirement of station staff was sought. The sets can be braked automatically, and they can be loaded by remote control via carrier current from the automatic load dispatching equipment at Shawinigan, some 20 miles downstream.

(To be continued)

Fig. 4—The St. Maurice River at Shawinigan Falls, showing "A," "B" and "C" power stations



Sliding Roof for Open Rail Wagons

SHEETING of open railway wagons to protect their contents is a time-consuming process which has had to be tolerated when dealing with goods unsuitable for loading into vans. A sliding roof to give these wagons protection without interfering with loading has been developed in France from a similar device for ships' holds, and over the past four years has been ordered by the French National Railways at the rate of some 500 a year. The roof was designed by MacGregor-Comarain, S.A., Paris, and prototypes have now been produced by Rubery, Owen and Co., Ltd., Darlaston, Staffs., as sole licensee in the United Kingdom to MacGregor and Co. (Cargo Handling), Ltd., 5, Camomile Street, London, E.C.3. A demonstration was given recently at Paddington goods yard of one of the roofs fitted to a British Railways 12-ton shock-absorbing wagon as used for the conveyance of steel sheet (Fig. 1).

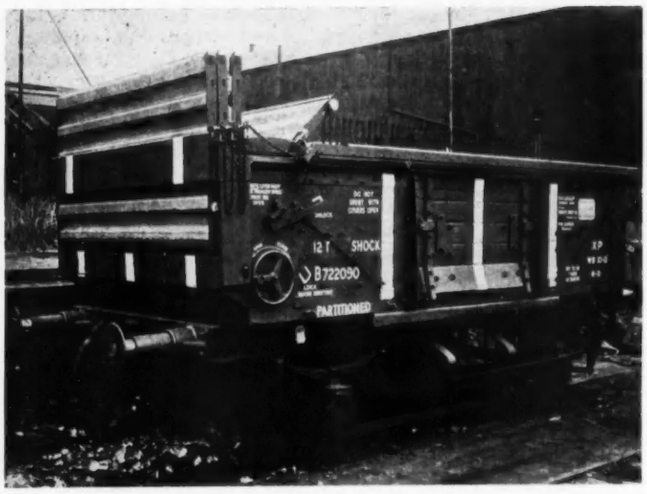


Fig. 1—British Railways shock-absorbing wagon fitted with four-panel sliding roof. Three panels are seen stowed in the magazine and the fourth is about to enter it to complete the opening procedure

For British purposes the roof is usually in four steel panels, but more or fewer can be introduced to cover the desired space. The ribbed panels overlap when the roof is closed to exclude water from the wagon, and are shaped so that water is drained to the sides and so into the roof runways, from which it escapes outside the wagon through further drainage holes (seen at *K* in Fig. 2).

The roof is operated by an endless chain driven by handwheels on each side of the wagon, which may be duplicated if required for convenience of access from ground level or a platform. While closed, the roof is secured by a double-wedge lock controlled by levers adjacent to the handwheels, and bears at the other end against a rubber joint inside the top frame of the wagon.

Details of the mechanism are shown in Fig. 2. The panels *A* are supported by running rollers *B* on a runway at each side of the wagon. There are two pairs of running rollers for the end, or driving, panel, but the remainder are supported while closed by one pair of running rollers and the pushing roller *D* of an adjacent panel.

To open the wagon, the roof is unlocked and an operating handle is turned. The endless chain *E* is coupled only to the end panel (this connection being shown in the diagram), which it pulls towards the magazine. The remainder are propelled towards the magazine by the pushing rollers. Each panel has intermediate swinging rollers *F*. On approaching the magazine, these rollers mount the swinging ramp *G*, so that the panels tilt vertically for stowage, the running rollers meanwhile travelling down an oppositely-inclined ramp *H*. Thus, as winding proceeds, the driving panel pushes the others up to the end of the magazine and finally assumes the vertical itself.

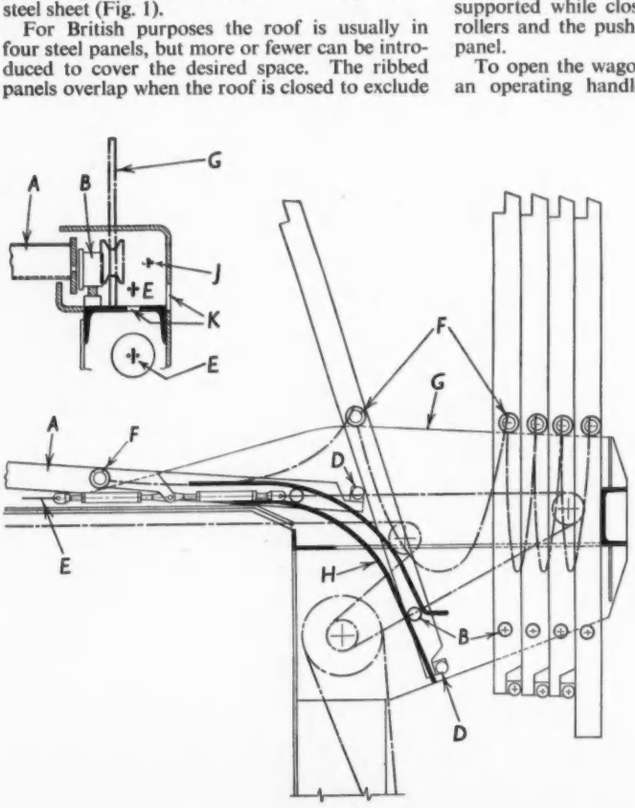


Fig. 2—Cross section of roller track and detail of guiding ramp into storage magazine

To close the roof the handwheel is turned in the reverse direction, the driving panel pulling the others after it by means of interconnecting chains *J*, two of which can also be seen in Fig. 1. The operation of opening or closing the roof takes one man less than one minute, with consequent savings both in time and manpower compared with the use of tarpaulins.

In the wagon demonstrated at Paddington a slight shortening of the body had been necessary to allow storage of some of the roof sections, when in the open position, within the original body area. The extent to which this has to be done varies from one installation to another. On the French National Railways, for example, the whole magazine is outside the body, space being available on the end platform. There are some cases where loss of body length can be compensated by raising the wagon sides so that the full cubic capacity is retained. The equipment can be fitted to wagons under construction or to older vehicles. In the latter case any reconstruction necessary to carry the roof runways, together with the additional strength imparted by these attachments, extends the useful life of the wagon.

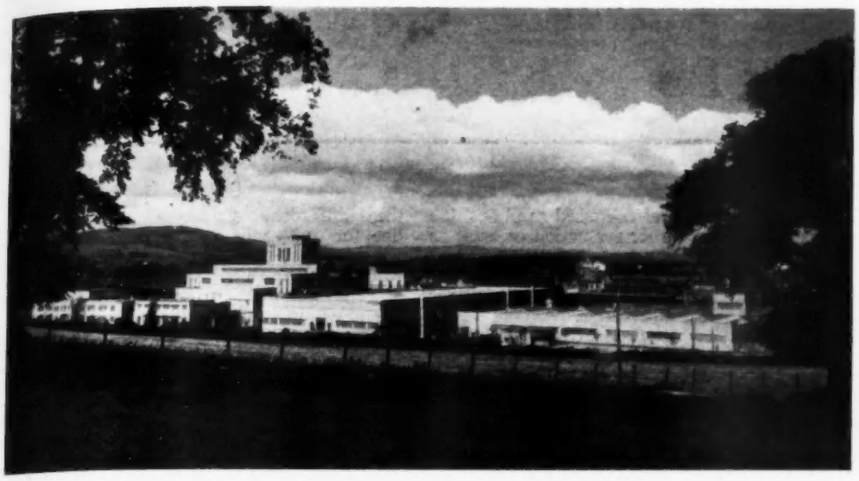
Orders have now been placed by British Railways for 100 covers to be fitted to new wagons to be manufactured this year : and twenty existing wagons in service with the Eastern Region are to be adapted to take the roof. Both these projects are being undertaken to satisfy a demand from the steel trade, one in connection with sheet and the other with strip. We understand from the designer of the roof that the development of its application to road goods vehicles is in hand.

Polyester Film Plant

THE illustration opposite is a general view of the new I.C.I. plant for manufacturing "Melinex" polyester film which was officially opened at Dumfries, Scotland, on Thursday, March 2, and has an annual production capacity of 2000 tons. Mr. J. C. Swallow, the chairman of the I.C.I. Plastics Division, speaking at the official opening, traced the history of "Melinex" and said that considerable sums of money had been spent on research to devise a suitable manufacturing technique and to design the production machinery. Work started in 1951 and two small experimental film units were built, one in 1953 and one in 1955. The production staff had to solve many manufacturing problems which were largely concerned with polymer physics and mechanical engineering and were of the same order of complexity as those connected with fibre manufacture. Among the problems to be solved was the making of two-way stretched film, free from defect, in a range of thicknesses and in widths of 48in with a very small thickness tolerance.

The decision to site the plant at Dumfries was announced in June, 1959 and one of the reasons for selecting this site is that it is suitable for further development. The plant is housed in a factory, which, until three years ago, was used for the manufacture of "Ardil" protein fibre.

"Melinex," although more expensive than the usual packaging films, differs from them radically in every property so that a much wider field of application is possible. In the electrical industry its high dielectric strength and availability in very thin gauges make it suitable for small condensers, capacitors and electric motor slot insulators while in cables it can be used both as a barrier against water or plasticisers and as a strong, thin dielectric lapping material. Due to its low gas permeability, excellent flexibility at



Polyester film plant at Dumfries

low temperatures and chemical resistance, "Melinex" has been used for lining hoses and for conveying gases, liquefied gas and corrosive chemicals. Furthermore, its dimensional stability finds it many applications in engineering and drawing offices where accuracy in plan drawing and plan reproduction is required.

Since the material contains no plasticisers it can be metallised by the vacuum process, and film metallised with aluminium is being used in the decorative field while non-tarnishing textile effect threads and laminated panelling materials are also made.

"Melinex" is made from the fibre-forming polymer "Terylene." The Plastics Division of the Company examined the plastics applications of the polymer and realised that "Terylene" possessed excellent film-forming properties, but a long programme of research had to be undertaken in order to develop a commercially useful manufacturing process. This exploited the unusual amorphous/crystalline structure of the polymer. A pilot plant at Welwyn Garden City, Hertfordshire, has been in operation since 1954, but although subsequently enlarged, the output of this pilot plant has permitted of little more than market evaluation. The new plant at Dumfries will satisfy all immediate requirements and now that it is in production it will be possible to do without the costly importation of American and Continental polyester films. All the processes of film-making are carried out in an air-conditioned atmosphere and under almost clinical conditions of cleanliness and hygiene.

Irradiation Experiments

A PAPER on "The Design of Irradiation Experiments," by J. R. Atkinson and S. Rigg, was presented for discussion at a meeting of the Institution of Mechanical Engineers at the Clarendon Laboratory, Oxford, on March 6. Extracts from the paper, summarising its contents, are reproduced below.

In the field of nuclear development it is generally recognised that because radiation in its most general sense interacts with matter, some changes in the latter must take place as a result of the imposed irradiation and that it must only be a matter of time before such changes can lead to phenomena detectable on a macroscopic scale.

Consider first the effects of radiation upon a uranium-type fuel element. The prime interaction is, of course, that of fission and the release of fission fragments immediately raises the first problem that where a single uranium atom originally existed in the lattice structure, two fission-product atoms must now be accommodated. These have either to find room for themselves within the original lattice or must eventually escape, for example, by diffusion to the surface. Further, severe local heating must accompany the loss of kinetic energy of the fission-product atoms. Heating will also be produced within the uranium owing to interactions of both γ rays and β particles with the uranium atoms. In addition the fast and slow components of the neutron spectrum can interact with the atoms of the uranium lattice without producing fission. These effects can produce marked changes in the fissile material and in fact the value of a fuel element may be determined to a large extent by the nature and magnitude of these changes, for example, swelling or growth.

With non-fissile materials irradiation can again produce a wide variety of effects. Neutrons can be captured or scattered, thereby promoting excitation or displacement of atoms within their local structure. The phenomenon of stored energy in graphite is by now almost a classic example of this. The interaction of γ rays and β particles both lead to internal heating and therefore can be expected to affect the ultimate nature of structural changes induced by the neutron interactions. For certain materials, for example, beryllium, specific nuclear reactions induced by neutrons may lead to atoms of large atomic volume—for example, helium—being produced.

For a gaseous non-fissile component within a reactor, for example, carbon dioxide, the irradiation phenomena observed are also due to γ rays. As might be expected, dissociation accompanied by the production of charged radicals takes place and a variety of surface reactions can then follow. With graphite, as in the Calder reactor, mass transfer of carbon atoms is observed and with small amounts of water vapour present, corrosive chemical reactions are enhanced.

It was in order to examine some of the phenomena mentioned above that research reactors such as "Pluto," "Dido," and the Dounreay materials-testing reactor (D.M.T.R.) were constructed. The design of experimental equipment for such investigations is, however, more difficult than for conventional apparatus used in association with cyclotrons or synchrotrons. In the latter, an external beam of radiation is available and therefore no faults with the apparatus used with the beam can affect in any way the working of the machine. In reactor irradiation experiments, however, the "target" is situated within the reactor itself and usually all the instrumentation is external to the reactor. Owing to the heat produced for the reasons outlined above, a coolant system must be regarded as an integral part of the target specimen and this in turn must absorb some neutrons and hence give rise to flux changes in the target area and further self-heating problems.

From this elementary description of how radiation can affect the structure and behaviour of materials, it will be appreciated that the effects will, in general, be strongly dependent on temperature. Hence precise definition of temperature and temperature gradients within the experimental specimen is frequently necessary, but owing to the complicated mechanisms of heat generation within both the target and rig structure the design becomes one of some complexity.

The purpose of this paper is to discuss the design and the main features of some experimental equipment (referred to in U.K.A.E.A. terminology as either a rig or a loop) which has been designed to carry out research investigations into some of the phenomena previously outlined.

The effect of in-pile irradiation on fissile and non-fissile materials is discussed briefly, distinction being drawn between the effects of neutrons, β particles and γ rays. The eight phases of an irradiation experiment are discussed and attention is drawn to the importance of the initial specifications. Methods for determining the fluxes and heat generation in test rigs are given. Five experiments are described in some detail. The description of the carbon dioxide semi-static experiment gives a method of controlling the non-fissile specimen temperature in-pile. The graphite-carbon dioxide dynamic mass transfer experiment is designed to investigate the transfer mechanism in graphite-moderated carbon-dioxide-cooled reactors. The liquid metal mass transfer experiment poses special problems of safety. The description of the water-cooled fuel specimen experiment shows how the temperature of the specimen is maintained constant even during pile shut-down. The advanced gas-cooled reactor (A.G.R.) fuel cluster experiment is described to show the difficulty of simulating operating reactor conditions in a materials-testing reactor.

The Philosophy of Irradiation Experiments

Irradiation experiments within the U.K.A.E.A. Development and Engineering Group are intended primarily to provide information needed for reactor design and operation. The higher-flux materials-testing reactors in the U.K. have small cores so that it is not possible to test prototype power-producing reactor fuel elements in them under design conditions. Fissile and structural material specimens can, however, be irradiated satisfactorily either separately or integrally as a fuel-can unit. The information to be derived from such tests alone is inadequate to guarantee the performance of a new fuel element but does provide the information needed to develop the fuel-element design and manufacturing process.

It is, of course, also evident that the D.M.T.R. type of reactor can and will be used more widely for studies of the effects of irradiation on microstructure; such experiments linked with the macroscopic or "project" type of experiment discussed in this paper can eventually lead to a much better chance of guaranteeing the performance of a given fuel for a given reactor. In addition, the development of continuous in-pile instrumentation is very necessary if full and proper use is to be made of the ability of the M.T.R. to carry out accelerated irradiation tests.

If the fuel elements to be tested are for a power-producing reactor which is a direct development of a previous type, the new fuel elements can usually be tested under design conditions on a limited statistical basis in the previous type of reactor. For the fuel elements of a prototype reactor, this is not usually possible and the new fuel-element concept is first tested under given design conditions in M.T.R.'s and then on a statistical basis when the prototype power-producing reactor is in operation. This is one of the most important functions of a prototype reactor.

A high-flux materials-testing reactor with a large core suitable for testing the fuel elements of prototype reactors on a limited statistical basis could be built but would cost in terms of effort, time and money almost as much as a prototype reactor so that there is no clear case for a high-flux materials-testing reactor with a large core. The alternative of making the prototype reactor its own fuel-element test facility is preferred.

SHORTER REPORTS

Pipeline Legislation

ANSWERING questions in the House of Commons last Monday the Minister of Power, Mr. Richard Wood, said "The Government has decided that it is necessary to legislate to secure in the national interest the orderly development of privately owned industrial pipelines. The legislation will provide that, where there are objections by public bodies or private individuals to a project, those objections may be heard at a public inquiry and that, in appropriate cases, the Minister's decision will be subjected to the approval of Parliament. Before I lay detailed proposals before Parliament I shall consult the various interests that would be affected. . . . So far as the Trunk Pipelines Bill is concerned, I have said on two occasions that it is impossible for the Government to support the Bill. As the House will realise, it would not be subject to the new procedure which the Government has decided should be applied to projects of this kind. I think the House would agree that the Trunk Pipelines Bill deals with a very important project, and it therefore might be expected to need this new procedure. . . . There is a great deal of information which the Government will want to collect from the interests concerned with a view to framing proposals for legislation . . . No decision has been taken about which Department would be responsible. It would not be possible to legislate in this session, but I see the need and I think the Government appreciates the need to make progress as quickly as possible."

Noise Survey

THE London County Council and the Department of Scientific and Industrial Research have now begun a survey of ambient noise and two vans are now employed in recording background noise in London.

The area to be surveyed is bounded on the west by the boroughs of Wandsworth, Fulham, Kensington and Paddington ; on the north by Hampstead, St. Pancras, Islington and Hackney ; on the east by Poplar, Greenwich, Deptford and Camberwell, and on the south by Wandsworth and Lambeth. It is approximately 36 square miles in extent and contains a fair sample of all the various activities in the County of London.

The Building Research Station of the D.S.I.R. is providing the vans and apparatus for this part of the survey. L.C.C. staff will be responsible for the positioning and connecting-up of the vans and the working of the apparatus at each of the sites.

Noise measurements will be recorded on magnetic tape at each site for about two minutes in every hour throughout a twenty-four hour period. An automatic timing mechanism in the vans will operate the recording apparatus. The noise recorded on the tapes will later be analysed in the Building Research Station laboratory where each of the two-minute recordings will be replayed. By means of a high-speed level recorder and a system of relays designed at the Building Research Station the percentage of the total time of the recording for which the noise falls into any one of fifteen five-decibel ranges will be determined. Other detailed examination such as octave and one-third octave analyses will also be made.

In addition to the main survey, the Council's Scientific Adviser will make detailed surveys of sound levels in selected areas with another vehicle and separate equipment. Special consideration will also be given to the measurement of noise levels at various heights inside and outside tall buildings, and to the evaluation of the effect of traffic noise on noise-sensitive buildings, such as hospitals, theatres and churches. The noise encountered is being measured directly with a high-speed graphic recorder and also recorded simultaneously on magnetic tape so that a full analysis can be made later in the physics laboratory and the noise level expressed as phons, the phons unit giving a truer evaluation of noise as perceived by the human ear. From the analysis it will also be possible to obtain the percentage of time for which noise was present at any particular level within a five-decibel range.

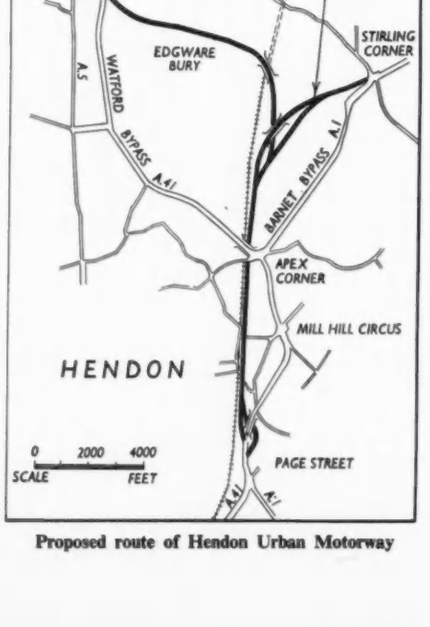
The L.C.C. has appointed Mr. N. Fleming, lately head of the accoustics section of the National Physical Laboratory, as consultant for the survey.

Moon Echo Signals to Australia

A FURTHER stage in the experiments in space communication being carried out under Sir Bernard Lovell at Jodrell Bank, in collaboration with engineers of Pye, Ltd., Cambridge, was announced on February 24, when it was reported that telegraphy and teleprinter signals had been transmitted from Jodrell Bank to Australia by reflection from the moon. This follows communication with America established by the same means on May 14, 1959. The signals to Australia were transmitted by a Pye 1kW amplitude-modulated transmitter, and the voice frequency teleprinter signalling equipment was manufactured by the Telephone Manufacturing Company, a member of the Pye Group. Reception in Australia was on a new 60ft radio telescope installed by the Commonwealth Scientific and Industrial Research Association at Sydney. Moon circuits are available between London and Sydney for approximately 1¾ hours a day, and between London and Perth for approximately 4½ hours a day.

Proposed Route of Hendon Urban Motorway

A DRAFT scheme to establish the line of the 4-mile Hendon urban motorway, from Page Street to Brockley Hill, on the northern approaches to London, has been published by the Ministry of Transport. The draft scheme also shows the route of a proposed link from the motorway to the Great North Road (A.1) at Stirling Corner, and the Ministry has invited the Hertfordshire County Council to survey a line for a 3½ mile stretch of motorway from Brockley Hill to the present end of the M1 Motorway at Aldenham. These two schemes together would bring the southern terminal of M1 to within 8 miles of Marble Arch.



Proposed route of Hendon Urban Motorway

The route proposed leaves Watford Way about 500 yards north of Five Ways Corner, Hendon, and follows a line on the east side of the Midland Region railway, passing under the Watford by-pass (Edgware Way) west of Apex Corner. It then sweeps round to cross the railway, passing to the north of Edgwarebury to a point on the London-Holyhead trunk road (A.5) at Brockley Hill, Harrow, south of the Brockley Hill roundabout. Apart from the proposed link to A1 at Stirling Corner, there will be no connections with other roads.

Five Ways Corner is selected as the London end of the urban motorway, the Ministry states, because it is a convenient point for traffic using the existing Watford Way and Hendon Way into the City and West End, while these roads also provide feeders to the North Circular Road.

The Ministry's consulting engineers, Messrs. W. S. Atkins and Partners, have recommended this route after investigating four other alternative suggestions. It is considered to be the only one capable of meeting traffic requirements and, since it runs for a considerable distance alongside the railway, will have the least possible disruptive effect on the urban community through which it passes.

The 3½ mile line which the Hertfordshire County Council has now been invited to survey runs roughly parallel to the A41 and it is hoped to publish the draft scheme later this year. A flyover junction will be provided near Brockley Hill between the Motorway and the A41.

Because of procedural and engineering preparation and land acquisition, it is not yet certain when work will start on the motorway. The Ministry states, however, that it hoped that this will be possible within two to three years.

Industrial Films

"FASHIONED IN STEEL," produced by the English Steel Company's film unit for the company's subsidiary, Darlington Forge, Ltd., is a film which deals with one of the lesser-known but very important branches of the steel industry—the making of heavy forgings and castings. It is a 16mm. sound and colour film, which runs for 38 minutes, and after a brief historical introduction, shows the complete procedure involved in making a large and complicated steel casting. The example chosen, a stern frame for an oil tanker, not only stresses the company's long association with the shipbuilding industry, but also illustrates the application of some heavy coring and drawback moulding. Following this shipbuilding theme the film goes on to show the making of a forged steel rudder post and cast steel propellor shaft brackets. Animated diagrams are used to explain the more difficult parts of the forging sequences, and models illustrate the fitting of the components into ships' hulls.

The film then turns to other types of heavy forging and casting, as used in the iron and steel, nuclear power and general engineering industries, and concludes with shots of heavy industrial plant such as blast furnaces, rolling mills, extrusion and bending presses, in which Darlington Forge products are used. A point which the film makes very clearly is that the production of heavy steel castings and forgings is essentially of the "one-off" type, calling for great skill and experience among the designers, pattern and template makers, moulders, forgemen, dressers and machinists who make up the production team.

A 16mm. sound and colour film running for 8 minutes, and produced for the safety committee of the British Steel Founders' Association,

deals with a different aspect of steel casting production. Entitled, "Your Eyes are Precious," the film shows the hazards to eyesight which can arise in steel foundries, and how they can be combated by the use of suitable safety equipment such as goggles and eye shields. It stresses the importance of obtaining skilled treatment for any eye injury, however small. Although the film refers particularly to conditions arising in steel foundries, the B.S.F.A. safety committee feels that the general theme is applicable to many other industries as well, and has therefore arranged for copies to be available on loan or for purchase by any interested party.

Railway Electrification Conference Proceedings

THE "Proceedings of the British Railways' Electrification Conference," are to be published in book form in April and will form one of the most comprehensive reference works obtainable on railway electrification on the 50 c/s alternating current system. They will be the first review of British technique in a.c. rail traction to be published. The conference was held in London from October 3 to 7 last year (see our October 7 and 14, 1960, issues). The proceedings will include the full text of forty-two conference papers and reports of the technical discussions. It is well known that since the conference was held, difficulties have been encountered in the operation of certain of the multiple-unit trains, and it is intended that a note about these problems and the way in which they are being overcome shall be included in the proceedings. Copies of the published proceedings, which include some 120 photographs and 175 diagrams, bound in blue cloth covers with the conference badge and lettering in gold, may be ordered in advance direct from the Publicity Officer, British Transport Commission, 222, Marylebone Road, London, N.W.1, at £5 a copy.

Approach Aids at Coventry Airport

VARIOUS improvements in connection with approach and landing facilities have been made at the Coventry municipal airport, Baginton, in anticipation of heavier traffic this summer and to meet B.E.A. requirements when Coventry is used as a diversion airport for scheduled services. Among these is the installation of a Decca 424 airfield control radar. This is a 3cm system of 20kW peak power, providing final approach control together with a measure of circuit and approach surveillance. The scanner of this equipment is seen in Fig. 1. Transmitter, receiver and display equipment are fully duplicated for instantaneous standby operation, and the polarisation of transmissions can be varied from the operator's position from linear to circular to mitigate the effect of rain or snow returns. The two P.P.I. displays are fitted with "Decaplot" anti-parallax reflection plotters engraved with the approach pattern, and capable of being marked with wax pencil to show a selected course line and the required altitudes at various ranges.

Fig. 1—Scanner of approach control radar at Coventry airport

The "Perspex" plotting surface of the "Deccaplot" is curved to match exactly the corresponding curvature of the P.P.I. screen and is mounted above it. Between the two is a partially reflecting mirror. When a mark is made in wax pencil on the edge-lit plotting surface to coincide with a particular point on the P.P.I. screen, its reflection is seen on the radar picture and its apparent position remains unchanged from any angle of view. When the edge-lighting is switched off, the marks cannot be seen and the P.P.I. picture can be observed normally.

The display provides azimuth information only, but this in conjunction with the controller's height instructions, and his observation on the display of the position of the aircraft and its distance from touchdown, provides sufficient final approach data for the circumstances of this airport.

The airport has also been equipped with an approach and runway lighting system supplied by The General Electric Company, Ltd., comprising high-intensity runway lights, high- and low-intensity approach lights and taxiway lights. As the first stage of a four-stage plan, the corporation has built a 5300ft main runway (06–24). At the north-east end of the runway is a 700ft stopway and at the other end a 600ft stopway. Provision has been made for the runway to be extended to the south-west, to give a total length of 9000ft. Approach lighting from the north-east consists of a 1400ft centre line of high-intensity lights with one crossbar 1000ft

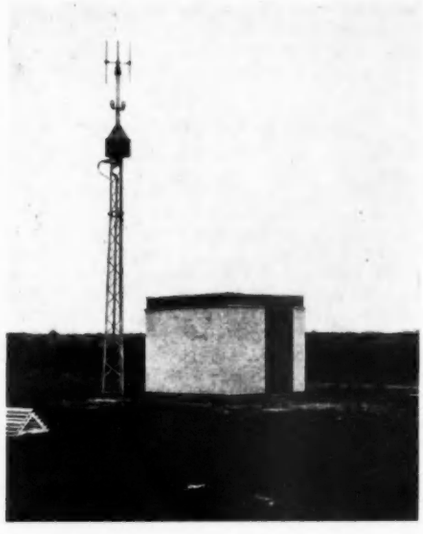


Fig. 2—Rotating d.f. aerial system on 28ft tower hinged at base

out from the threshold. The south-west approach pattern is similar but uses low-intensity lights. Runway lighting consists of bi-directional, high-intensity elevated lights spaced 200ft apart. The standby diesel alternator set for the lighting is by A. C. Morrison, Ltd., Southampton.

A further facility installed in the course of these improvements is an Ekco automatic v.h.f./d.f. equipment, CE178. This apparatus takes a simple form bearing some resemblance in principle to d/f working with a manually-operated goniometer, although the Adcock aerial is rotated continuously and determination of null bearings is fully automatic. To compensate for variations in sharpness, the nulls are applied after the second detector stage of the receiver to a pulse generator circuit in which corresponding narrow pulses of constant width are formed. This circuit consists essentially of a single-stroke timebase which is triggered at a predetermined voltage before the null and runs at half speed until the signal attains the same predetermined level after the null. From this point the timebase continues at full speed until flyback. A narrow pulse is formed from the flyback, occurring with a constant delay after the mid-point between the instants at which the signal reaches the same voltage before and after the null. Broad nulls, which are outside the working range of the equipment, are excluded by a width gate.

The narrow pulses from the pulse generator unit are applied to a magslip resolver transmitter coupled to the aerial shaft and thereby split into sine and cosine components relative to aerial positions. These components are applied to the scan coils of the 6in cathode ray tube on the indicator unit, producing a single radial line without sense ambiguity. Presentation may be either as QDM or QTE.

The Adcock aerial assembly, with central sense dipole, is mounted at a height of 28ft on a tubular steel tower (Fig. 2) which is hinged at the base for simple lowering for maintenance. The rack assembly containing the principal equipment is housed in the adjacent building. It comprises a receiver, two units for deriving display pulses from the aerial bearing information, a remote control termination unit and two power units. Fig. 3 shows the d.f. operator's

Fig. 3—D.f. operator's position in control tower

position in the control tower. Controls on the left and right below the screen adjust the edge-lit scale illumination and the display brilliance respectively, while the central switch selects bearing or magnetic reciprocal presentation.

Ship Structures Congress

THE aim of the International Ship Structures Congress is to give experts, in different countries, engaged in research work on ship structures and ship strength problems an opportunity to meet at intervals to discuss questions of common interest, exchange information about results obtained and possibly plan further research, especially where comparison from different countries is of interest or when a standard procedure is to be recommended. The Congress is to meet every three years and three committees have been formed, namely: Committee on long range research programme in ship structural design; committee on wave loads; and committee on response to wave loads. These committees will plan research work and prepare reports which will be discussed at the Congress. The first meeting of the Congress will be held at the University of Glasgow on September 19, 20 and 21, when the following subjects will be discussed: wave loads; response to wave loads, still water bending moments; low cycle fatigue; cut-outs and stress concentrations; thermal stresses; superstructures; orthogonally stiffened plating; corrugated bulkheads; brackets; dynamical pressure in tanks; ship vibration and the structural design of large tankers. Professor J. F. C. Conn is the chairman of the organising committee on which serve representatives from France, Germany, Japan, Netherlands, Norway, Sweden and the U.S.A.

SHORTER REPORTS *(Continued)*

Anti-Corrosive Additive Feeder

THE anti-corrosive preparation " Aqua-Clear," which is claimed to protect water circulation systems irrespective of the quality or temperature of the water, is used in liquid form as an additive for the treatment of recirculating systems, at the rate of 1 pint per ton of water in the system, while for wasting systems a feeder is used. This " Aqua-Clear " feeder is constructed of mild steel and is of cylindrical form fitted with mild steel perforated baskets containing the additive in hard crystal form. The feeder is incorporated into the system at source so that the water passes through and slowly dissolves the crystals, and the " Aqua-Clear " is carried forward into the pipelines. An air release valve ensures that air does not collect at the top of the feeder and to obtain the correct dosage it is essential that the surfaces of the crystals are kept clean. Cleaning is carried out using fresh water or if the crystals are coated this can be removed by washing in a 10 per cent hydrochloric acid solution. The size of feeder is determined by the throughput of water and there are nine sizes available. These range from model 6C, which has a capacity of 550 gallons per hour and measures approximately 31in in height by 6in diameter, to model 40K, which measures 56in in height by 40in diameter and has a maximum capacity of 59,400 gallons per hour. According to a field report, received from Kinnis and Brown, Ltd., in a factory which uses cooling water, drawn from wells, having a high iron content as well as being contaminated by marshy conditions, the installation of an " Aqua-Clear " feeder has ensured ten months' service without pipeline replacement as against the normal period of three months. Furthermore, during the same period the coolers have been constantly in service whereas the previous period between shut down for cleaning was three weeks.

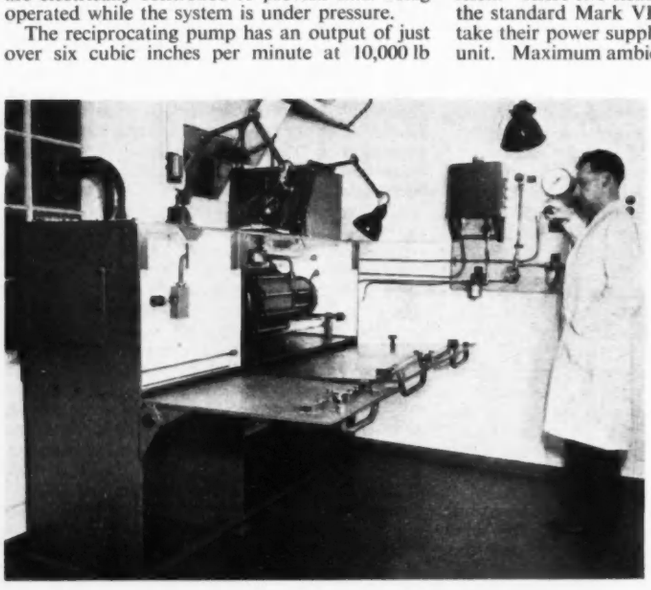
[Reply Card No. E3861]

High Pressure Hydraulic Pump

To meet the demand for high hydraulic pressures required in industry and by research establishments Charles S. Madan and Co., Ltd., Altrincham has added a new model to the range of " Airhydropumps." This pump produces pressures up to 100,000 lb per square inch from compressed air at 80/100 lb per square inch. Our illustration shows the pump mounted in a steel safety cabinet with a separate compartment for the article under test and with all controls mounted outside. The pressure gauge is viewed through mirrors and the doors of the cabinet are electrically controlled to prevent their being operated while the system is under pressure.

The reciprocating pump has an output of just over six cubic inches per minute at 10,000 lb per square inch falling to just under two cubic inches per minute at 90,000 lb per square inch, the pressure being controllable over this range by the air control valve. Pressure may be raised gradually by hand, or alternatively, the air control valve can be set to produce the required pressure. When the air supply is switched on the pump reciprocates until the preset pressure is reached when it comes to rest in a state of balance and the pressure will be maintained indefinitely without consuming any air. If there is a leak in the article under test the pump continues to reciprocate.

[Reply Card No. E3862]



Compressed air driven hydraulic pump for pressures up to 100,000 lb per square inch

Mobile Gas Turbo-Alternator

A MOBILE version of the 3MW generating set employing the " Proteus " gas turbine has been announced by Bristol Siddeley Engines, Ltd. ; applications envisaged for it include replacement of existing sets in periods of maintenance on emergency overload, service with contractors on construction sites, and local supply after failure of transmission systems. The generator pack is complete with silenced intake and exhaust systems ; it is mounted either on a rail flat car or a semi-trailer, although, being 34ft by 9ft by 9ft and 20 tons in weight, it exceeds the legal limits for road vehicles in Great Britain. Where it is to be applied apart from an existing power station, there is also required a control pack 17ft by 9ft by 9ft and 5 tons 15cwt in weight.

The " Proteus " is now available with a fuel system permitting operation on natural gas ; it is claimed that, in the case of suitable sources of gas, no loss of performance is involved.

[Reply Card No. E3863]

Miniature Television Camera

FOR industrial and other purposes where conditions prevent installation of a television camera of normal size, the miniature unit illustrated has been introduced by E.M.I. Electronics, Ltd., Hayes, Middlesex. The E.M.I. " Minicamera " (BC601) is for closed circuit systems and is appliable to purposes such as pipe viewing, use in connection with nuclear reactors, wind tunnel and rocket motor test bed observations, and medical work. It can be placed inside an operating theatre lamp so as to provide an unobstructed view of an operation for a large audience.

The camera contains a 1in Vidicon tube and a ceramic triode head amplifier, and is connected to a separate pre-amplifier so that as few components as possible need to be placed in the camera itself. These two items are designed for use with the standard Mark VI camera control unit, and take their power supply over the cable from that unit. Maximum ambient operating temperatures are 165 deg. Fah. for the camera and 122 deg. Fah. for the pre-amplifier. No ventilation is required for the camera, the absence of apertures for the purpose making it convenient for use where dust and swarf are present. When protection from adverse conditions is required,

Camera with 1in Vidicon tube for closed circuit television. Length of the cylindrical body is 9in and diameter 3in

housings are to be made available which will be proof against dust, water, steam and acoustic interference. These also will be of lightweight construction. Focusing is by hand, but remote control can be fitted for this purpose if required, as well as for zoom, iris, pan and tilt.

The length of the camera from lens mount to backplate is 9in, the diameter 3in, and the weight 6 lb. The pre-amplifier measures 6in by 8¼in by 5¾in (excluding plugs and sockets) and weighs 5 lb.

[Reply Card No. E3864.]

Measurement of Engine Temperatures

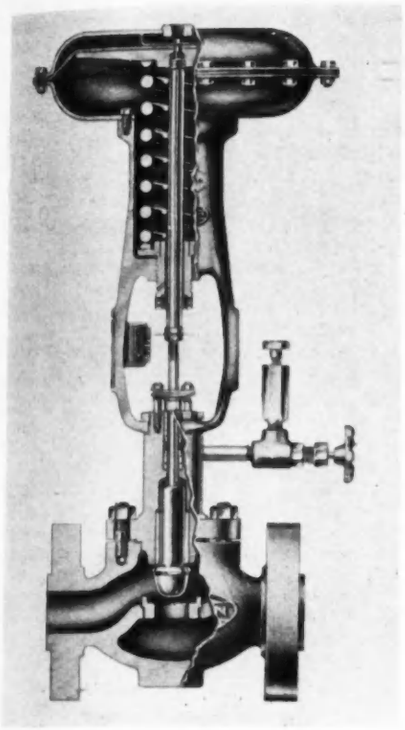
AT its centre at Thornton, Cheshire, " Shell " Research, Ltd., has developed a simple method for measuring the operating temperatures of engine parts such as valves and pistons. Temperature measuring devices cannot easily be attached to rapidly moving parts inside the engine block but, at Thornton, a technique has been developed whereby each component registers the maximum temperature to which it has been exposed. When the engine is dismantled this temperature can be deciphered in the laboratory.

High temperatures can build up locally in pistons, rings, bearings, gears and valves and if they becomes too high, premature failure can result. By the use of this new technique engineers can now pinpoint these hot spots and take action to effect a remedy. The new technique, known as the " hardness relaxation " method, depends on the fact that when certain alloys are heated and then cooled, their original hardness is changed. The extent of the change depends on the maximum temperature reached, a fact which is not new but which has now been applied to measuring the temperature of moving parts in car engines and in larger units used in trains and ships. In general, it is only necessary to compare the original hardness of an engine component with its hardness after service to determine accurately the maximum temperature attained in the range 100 deg. to 1000 deg. Cent. (212 deg. to 1832 deg. Fah.). However, when the metal of a component is not suitable for the use of this method to determine the maximum temperature, small inserts of a suitable alloy can be inserted in the part under study. The change in hardness of the insert will enable the maximum temperature reached to be measured. A wide range of alloy inserts have been developed at the Thornton Research Centre.

[Reply Card No. E3865]

Heavy Duty Valves

A HEAVY-DUTY single-seat globe valve has been added to the "Masoncilan" series made by the Crosby Valve and Engineering Company, Ltd., Alperton, Wembley, Middlesex. A sectioned photograph of this valve reproduced below shows how extra heavy top guiding is given to the plug to eliminate need for orthodox bottom guiding. This construction also reduces



Heavy-duty, single-seat control valve

turbulent flow and troubles caused by any solid particles in suspension in the fluid handled. The body and part of the valve are designed to give a streamline flow and a high rate of flow through a given seat diameter. It is stated that this valve will withstand a greater out-of-balance pressure across the seat than the company's orthodox single-set control valves and still give a tight shut-off with stable throttling control.

These valves are available screwed ¾in to 2in, with trim sizes of ¼in, ⅜in, ½in, ¾in, 1½in and 2in, and flanged from ¾in to 10in with not less than four trim sizes for each line. Each size of valve is thus available with a wide range of interchangeable reduced area plugs and seats for temporary conditions, laver flows, higher pressure drops, and later increased throughput. The standard valves have carbon steel bodies with stainless steel trims and other materials can be used to suit special conditions.

[Reply Card No. E3871]

Improving Air Traffic Control Procedures

ADDITIONAL to the installation of a Ferranti "Apollo" computer at the Scottish Air Traffic Control Centre, Prestwick, this summer, the Ministry of Aviation has announced complementary basic research to be carried out by the Air Traffic Control Experimental Unit. Equipment for this purpose will include an Elliott 502 computer to be supplied by Elliott Brothers (London), Ltd., as the central data processing unit. The experimental system to be set up around the computer will simulate the control of aircraft flying in the London Flight Information Region, the computer being designed to accept and distribute simulated or live data, to carry out calculations, and to operate electronic or electromechanical indicators. Opportunities will thus be available for evaluating new procedures in which data derived from radar (both primary and secondary), airborne navigational aids, flight plans, &c., are fed into computers, with the intention in the first place of developing the present A.T.C. system to maximum efficiency. Secondly, new procedures and techniques will be evaluated with a view to the handling of new aircraft and the increasing volume of air traffic.

The "Apollo" computer due to begin operation at Prestwick this summer was described in our April 29, 1960, issue, and the facilities it will provide were reviewed in a paper presented by MacMullen, Bray and Llewellyn to the symposium entitled "A Survey of Data Handling for Air Traffic Control" which was held at the Institution of Electrical Engineers on April 8 last year (see our April 15, 1960, issue, pages 638-39). It is hoped that much will be learned from the operation of the computer of how this form of apparatus can be harnessed to the real-time problems of air traffic control. While these Prestwick experiments are associated principally with the Atlantic, it is expected that the results will prove valuable for application in other areas.

Self-Adhesive Wrapping

THERE has been announced by Spicers, Ltd., Langston Road, Loughton, Essex, a wrapping material to be known as "Spi-seal"; it consists of kraft paper coated on one side with an adhesive which sticks only to itself. It is intended primarily for the protection during storage or transit of sensitive surfaces, providing a near-impervious envelope which will reduce atmospheric attack, but it also forms a convenient method of keeping captive spares, accessories, and small detached parts. The adhesive is claimed to be completely neutral and to neither stain nor discolour paints, lacquers and varnishes.

The material is available in reels of widths up to 45in, and separate pieces can, of course, readily be joined. It can be used for flow-line packaging in special-purpose machines, and will allow a much higher throughput in plant designed to use thermo-plastic film, since the dwell for heating and sealing is eliminated.

Where a packaging material with cushioning properties in addition to ease of application is required, the manufacturers offer a resilient material termed Self-adhesive "Carbion."

[Reply Card No. E3873]

Coal-Fired Packaged Boilers

COCHRAN AND CO. (ANNAN), Ltd., has developed from its Series II vertical oil-fired packaged boilers, which was introduced in 1959, a new range of vertical, multi-pass, coal-fired packaged boilers. These, known as the Coal-Fired Series II, have the same efficiency and evaporation as an oil-fired unit of the same capacity, an efficiency of 80 per cent on the gross calorific value being claimed in addition to being economical in running costs. The range includes eleven units the particulars of which are recorded in the accompanying table.

Evaporation from and at 212 deg. Fah. lb/hour	Diameter ft in	Height ft in	Approx. weight (empty) including brickwork, cwt	Approx. water capacity at working level cwt
1750	4 9	12 9	111	36
1950	5 0	13 6	124	44
2200	5 3	14 0	140	47
2700	5 6	14 0	155	54
3300	6 0	14 9	194	68
4150	6 6	15 3	221	83
4950	7 0	16 0	257	103
6100	7 6	17 3	311	126
7200	8 0	17 9	351	154
8300	8 6	18 3	415	169
10,000	9 0	19 0	528	231

The boilers are suitable for high or low-pressure hot water applications and coal-fired evaporation is independent of the quality of the fuel.

The unit is of all welded construction and is fitted with a special chain-grate, which incorporates principles developed by the British Coal Utilisation Research Association, and which gives smokeless combustion with a wide range of coals and has a turn down ratio at least equal to that of oil. Withdrawal of the complete stoker unit for inspection and maintenance is comparatively simple since the chain-grate is floor mounted on rollers which run in channel irons. Ash is discharged to the far end of the boiler either directly into a barrow contained within the boiler's skirt or into a hopper from which it can be extracted by a screw conveyor. There is also an induced draught fan, and comprehensive automatic boiler control.

It is of interest to note that the boiler can accommodate an oil burner so that dual firing is possible, and that the Series II oil-fired unit can be converted by lengthening the boiler skirt by 1ft 9in; additional bricking in of the furnace; and the mounting of an induced draught fan.

[Reply Card No. E3874]

Semiconductors for Industry

EXAMPLES of semiconductor applications from a wide range of industry and science have been assembled in an exhibition held this week by the Semiconductor Division of Mullard, Ltd., at Mullard House, Torrington Place, London, W.C.1. The exhibition closes to-day, March 10. At the company's Southampton plant a system of statistical life testing has been introduced for obtaining reliability data, a task which becomes increasingly difficult as the failure rate decreases. Examples are shown of the test jigs, each accommodating 100 transistors, which are plugged into controlled ambient ovens and carry multiway connectors for the life test circuits and power supplies. Data are recorded on punched cards and analysed by computers. Every day over 10,000 transistors are interrogated by this equipment and during this year life test experience has been recorded at the rate of 40,000,000 recorded hours a year. Next year the figure will be increased to 80,000,000 hours, and in the following year to 120 million. During the exhibition there have been showings of a new series of Mullard ten-minute filmstrip lectures on technical subjects. Six titles dealing with transistor circuits, quality control and testing have been prepared, and the range will be extended. At Mullard House the filmstrips are exhibited in conjunction with a lecture recorded on two-track tape, one track for the text and the other for tone signals which automatically change the picture as appropriate. It is hoped to make this range of lectures available on free loan to interested organisations, and presentation with manual change of picture and with a script will be catered for.

Among the application exhibits, the growing interest in transistors for lift control was exemplified by a working model of a five-floor installation controlled by Mullard plug-in logic elements, this scheme being shown by Keighley Lifts, Ltd. A transistorised servo system for aircraft nosewheel control was shown by Dowty Electrics, Ltd., in which an out-of-balance signal in a bridge circuit created by movement of the rudder bar is applied to a transistor amplifier for operation of electro-hydraulic valves. An a.c. generator set with transistor control unit as fitted in London Transport "Routemaster" buses was shown by Simms Motor Units, Ltd. Among telecommunications exhibits, a communications receiver for 169 Mc/s using alloy diffused transistors was shown, together with a 2·5W transmitter for 5 Mc/s and a 4W transmitter for 500 kc/s.

[Reply Card No. E3875]

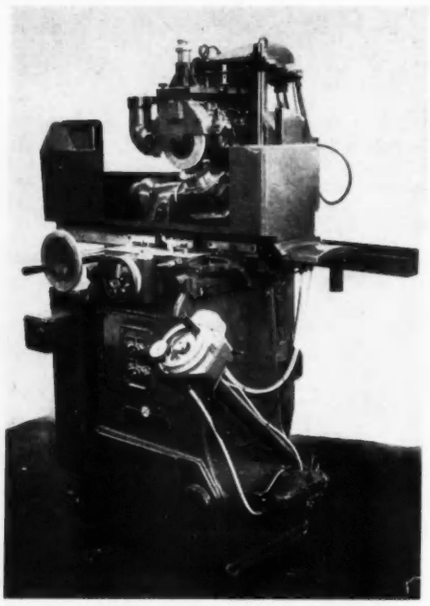
Water Development in Nyasaland

AN agreement was signed on Monday, February 27, by which the Colonial Development Corporation will lend up to £1,300,000 to the Mudi River Water Board in Nyasaland, a statutory Board responsible for procuring water supplies for the urban areas of Blantyre and Limbe. A four-stage scheme for a supply system which will pump up to 9 m.g.d. from the Shire River some 26 miles away is envisaged, the total cost of which is estimated to be about £5,500,000. The first stage has now been adopted, and will take about three years to complete at a cost of £2·3 million. It will be capable of supplying 1½ m.g.d. into the existing reticulation system.

SHORTER REPORTS *(continued)*

Automatic Cutter Grinding Head for Surface Grinding Machine

AN automatic cutter grinding head has been developed by A. A. Jones and Shipman, Ltd., Leicester, for mounting on the model "540" surface grinder. The operation of this head is fully automatic, the indexing mechanism being operated by the table traverse and the down-feed applied automatically. For this down-feed the cutter spindle operates a limit switch on the head once every revolution, applying the feed by energising a solenoid-operated valve in the down-feed hydraulic circuit. The machine illustrated



Surface grinding machine fitted with automatic cutter grinding attachment for circular gear cutters

is equipped with the standard automatic down-feed unit fitted with a special screw and worm gearing to give a down-feed range of 0·0003in to 0·0015in, one revolution of the handwheel giving a feed of 0·060in against the standard of 0·020in. This down-feed unit applies the feed in preset increments until stopped by the adjustable trip mechanism on the column; when the down-feed has ceased and after a sufficient spark-out period has elapsed the table traverse is stopped manually.

The attachment on the machine illustrated has been specially designed to sharpen automatically circular gear cutters with varying numbers of teeth and a fixed top rake of 5 deg. normal to the helix angle. Both left-hand and right-hand cutters can be accommodated. The driving shaft and cutter spindle are both mounted in ball bearings to minimise load on the mechanism. An 8in diameter grinding wheel is used in this case. To ensure stability during grinding a saddle lock is fitted, and an adjustable safety stop on the forward traverse of the table prevents the table being accidentally traversed past the reversing dog thus running the grinding wheel into the opposite side of the cutter.

A cam plate is fitted to the machine at the rear so that as the table traverses rightwards a follower arm on the attachment engages with the cam to impart the indexing motion. The angular motion of the follower arm is transmitted through a pawl and ratchet wheel and bevel gearing to the cutter marking spindle. Interchangeable indexing discs with different numbers of teeth are carried at the lower end of the cutter spindle. The indexing disc in use engages a spring loaded "V"-point lever which automatically locks the spindle as the attachment passes under the wheel. Control of the indexing accuracy is solely by the indexing disc and the "V"-point lever, the function of the pawl and ratchet mechanism being only to impart rotation to the indexing disc. It is this over-riding control of the ratcheting motion which enables the attachment to accommodate cutters with from twenty-eight to thirty-eight teeth.

A bracket carrying the cutter head spindle can be rotated up to 40 deg. either side of the zero position for both left-hand and right-hand cutters and a graduated indexing ring is provided for registering the angular setting of the bracket before it is locked in position by a clamping lever. Separate locating pieces are provided for setting each cutter in the grinding position on the spindle.

[Reply Card No. E3881]

Portable Trigger Generator

THE use of semiconductor devices has allowed the production of a compact portable trigger generator capable of delivering fast, high-voltage triggering pulses from a low source impedance. The instrument, which we illustrate, has been developed by Winston Electronics, Ltd., Shepperton, Middlesex, and operates from two Ever

Battery-operated trigger pulse generator

Ready 67·5V B.101 batteries. Load capacity is stated to have a negligible effect on the rise time, being reflected only by a small reduction in size of the output pulse and a slight shift in the pulse recurrence frequency. Positive and negative going pulses of differentiated "spike" form are generated.

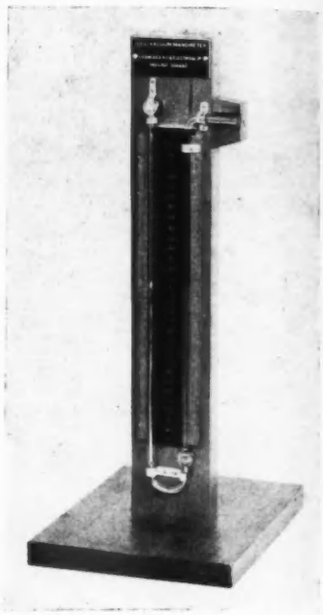
The available functions are free running operation (p.r.f. 10 pulses to 10 kilopulses per second), synchronisation of the free running condition, triggered operation (d.c. to 50 kilopulses per second) with variation of the trigger level threshold, and single-cycle operation by push button. A separate mains power unit can be supplied for operating the generator if required.

[Reply Card No. E3882]

Vacuum Manometer

A VACUUM manometer developed at the National Engineering Laboratory, is now being made by N.G.N. Electrical, Ltd., Accrington, Lancs. In announcing this new instrument the maker points out that the conventional type of U-tube portable vacuum manometer is unreliable due to leakage of air into the closed limb. This leakage introduces errors of measurement which increase rapidly at higher pressure measurements and the manometer developed at the National Engineering Laboratory is designed to reduce these errors.

In this manometer, illustrated herewith, a bulb is blown at the top of the closed limb to provide expansion space for entrapped gas which arises either by leakage past the mercury column or by evolution from the mercury itself. An



Portable vacuum manometer

identical bulb is blown at the bottom of the open limb to receive the mercury which falls from the other bulb when the manometer is connected to vacuum. In order to minimise the "hammer" effect when the vaccum is suddenly released a short length of small bore capillary tube is used to connect the two limbs.

The range covered by the instrument available is 0 to 300mm Hg and the reduction in error compared to a conventional U-tube manometer with the same volume of entrapped gas is from 17mm Hg error to 0·33mm Hg error at 300mm Hg.

[Reply Card No. E3883]

Xenon-Filled Rectifier

AMONG the hot-cathode gas-filled rectifiers, the valve with a xenon filling is characterised by a short warm-up time and ability to operate in a wide range of ambient temperatures. A grid-controlled rectifier of this kind, with disc-sealed construction, has been introduced by the Industrial Valves and Cathode Ray Tubes Department of A.E.I. Radio and Electronic Components Division, 155, Charing Cross Road, London, W.C.2. This Ediswan 21B12 valve is a direct replacement for the American C3JA and conforms to JAN (Joint Army and Navy) specification, and is intended for motor control, welding ignition control and other duties requiring a controlled characteristic. The disc-sealed construction has the advantage of mechanical robustness and maintains the electrical characteristics to closer limits, while risk of backfiring is reduced, and valve life is increased. Warm-up time is approximately thirty seconds. The 21B12 is directly-heated, taking a filament current of 9A at 2·5V, and is designed for a maximum peak anode forward voltage of 1kV and maximum peak inverse anode voltage of 1·25kV. Maximum mean cathode current is 2·5A and the peak 30A, and the ambient temperature range is −55 deg. to +75 deg. Cent.

[Reply Card No. E3884]

INDUSTRIAL NEWS

Technology and Science Outside Universities

Speaking at the opening of a new students' hostel at the Battersea College of Advanced Technology last week, Sir David Eccles, Minister of Education, outlined the advance made in the field of technology and science outside the universities. There were to-day, he said, some 100,000 students in all the British Universities taken together. They had secured their "A" level G.C.E's and were studying for a degree. But how many people knew, he continued, that outside the universities there were almost another 100,000 students studying courses beyond the "A" level of the G.C.E. ? Sir David explained that 30,000 were studying in the evenings, 40,000 were studying in part-time day courses, and 24,000 were studying in full-time and sandwich courses. Out of this second 100,000, Sir David added, were produced three times the number of engineers who came out of universities.

If he read the signs aright, Sir David said, every year industry appreciated more keenly that the Colleges of Advanced Technology were the nurseries of the men who would develop the inventions of the scientists, and remove from Britain the commonly heard complaint that our best brains were brilliant in pure theory, and could produce new ideas but could not with equal brilliance turn their thinking to practical account in the world of production and commerce. This was the reason, Sir David said, why industry was lending more staff and equipment to the Colleges of Advanced Technology, and sending to them more students, so that a figure like the total of sandwich students hit a new record every year.

Technical Education in Wales

The Central Advisory Council for Education (Wales), under the chairmanship of Mr. A. B. Oldfield-Davies, has published its report. The Council was given the specific terms of reference : "In the light of contemporary changes in the industrial pattern in Wales, to consider what educational provisions should be made to serve the best interests of industry and those employed in it."

The report states that the provision of technical education in Wales is now "more than adequate," but, the Council adds, the support from industry for sandwich and other advanced courses offered has been "very disappointing." The solution to the problem of providing industry with the increasing number of highly qualified people it needs lies, to a large extent, in industry's own hands, the report comments. The facilities for training are available, but, in general, industry—though ready to release its employees one day a week to attend part-time courses, seems reluctant to offer them the opportunity to attend advanced full-time or sandwich courses. On the other hand, the Council says, part-time day release figures have trebled since 1947.

The Council calls for the establishment of a national craft apprenticeship system which would free individual industries from the responsibility for providing craft training. Among the Council's other recommendations and suggestions are that advanced technical courses in Wales, for which highly qualified staff and expensive equipment are needed, should be restricted to five technical colleges which should be administered by an Administrative Council ; greater co-operation between the Welsh College of Advanced Technology and industry and other technical colleges; advanced sandwich diploma and university degree courses should be generally adopted as the accepted route to the status of technologist ; and the principle of releasing apprentices with pay to attend technical courses throughout their apprenticeship should be followed more widely.

Trade with East Germany

Negotiations between the Federation of British Industries and the Chamber of Foreign Trade of the German Democratic Republic on the bilateral trade arrangement for 1961 between Great Britain and the Republic have resulted in a £4,000,000 increase over last year's agreed total volume, according to the East German Ministry for Foreign Trade. This represents a 28 per cent rise—from £14,000,000 to £18,000,000—in the volume of trade which it is envisaged will pass in both directions during 1961.

According to the Board of Trade figures, actual trade realised in 1960 amounted to about £6,300,000 for British imports and £7,000,000 for exports to East Germany, against last year's agreed quotas of £7,000,000 for trade in each direction.

The United Kingdom is expected to export iron, steel and non-ferrous metals to the value of £3,500,000 to East Germany this year, together with machine tools worth £220,000 and chemical plant worth £200,000. Potash, worth some £2,500,000, will be imported from East Germany. Great Britain has agreed to increased import quotas for a variety of East German products, including machine tools, increased by £55,000 to £295,000.

Engineering Statistics

The flow of new orders to the industries producing engineering and electrical goods, locomotives and railway track equipment, railway carriages and wagons, heavy commercial vehicles and wheeled tractors was maintained in the closing months of 1960, the Board of Trade states. Deliveries by these industries to both home and export markets were increasing, after allowing for seasonal variations, throughout 1960 and by the end of the year had reached the level of net new orders. The volume of orders on hand, which had increased 16 per cent during the year, was then no longer rising.

In the engineering and electrical goods industries, the Board says, the volume of production in the fourth quarter of 1960 was 4 per cent more than a year earlier. Exports of the products of these industries in 1960 were 8 per cent more than in 1959.

Iron Castings

The Iron and Steel Board announces that the production of iron castings in the fourth quarter of 1960 was 1,024,690 tons. The output for the year was 3,967,570 tons compared with 3,498,030 tons in 1959.

Commenting on the figures the Joint Iron Council says that only in the automobile and pressure pipe sections of the industry did output fall at all noticeably, and this reduction was confined to the later months of the year. The automobile section, which had a busy year in 1959, went ahead again in 1960, the Council says, exceeding the previous year's output by 12½ per cent. The engineering section experienced steady progress as general capital expenditure on plant and machinery rose. The production of ingot moulds rose steeply in 1960 to 539,700 tons compared with 389,400 tons in 1959, and in the railway equipment section, which had experienced rather weak trading conditions up to the middle of the year, a marked increase in output was achieved in the second half.

The number of people employed in the ironfounding industry at the end of December, 1960, was 131,400. This was 100 more than three months ago, the Council says, and 3900 more than at the end of December, 1959.

Unemployment

The Ministry of Labour reports that on February 13 there were 389,680 people registered as unemployed in Great Britain, of whom 341,780 were wholly unemployed and 47,900 were temporarily stopped. The total included 48,547 married women and 3132 school-leavers. The number of people unemployed for more than eight weeks was 180,801.

During the period January 17 to February 13, unemployment fell in almost all industries and services, the Ministry says, the largest reduction being 14,200 in motor vehicle manufacturing, including 13,800 people who had been temporarily stopped, 5900 in the construction industry and 1200 in the engineering and electrical goods group, including 1000 who had been temporarily stopped. The decrease of 12,800 people unemployed in manufacturing industries as a whole included a decrease of 11,000 temporarily stopped workers. In shipbuilding and marine engineering the number of unemployed rose by 1012.

In the four-week period ending February 8, the Ministry says, there were increases in the number of unfilled vacancies in most industries and services, including 1800 in manufacturing industries, 2100 in construction, 1900 in miscellaneous services and 1000 in transport and communication.

European Common Market

Imperial Chemical Industries, Ltd., announced last week that if negotiations for acquiring a 300-acre site near Rotterdam are satisfactorily completed, it intends to build there a complex of chemical plants manufacturing petroleum chemicals including plastics and related products. Construction is expected to begin early next year and it is envisaged that up to £100 million will be spent in the next ten years.

Detailed plans for the starting of large-scale manufacture within the Common Market have been in preparation, the Company says, since July, 1960, when I.C.I. set up a European Council to review the whole position and make recommendations. This body has now been established as an operating board. The company states that the establishment of manufacturing units on the Continent will not mean any relaxation of its efforts to increase exports from the United Kingdom.

PERSONAL AND BUSINESS

Appointments

MR. R. A. RICHARDSON has been appointed a director of OSMA Plastics, Ltd.

MR. ERIC WOOD has been appointed home sales manager of Robert Hudson, Ltd.

MR. GORDON COLE has been appointed sales manager of W. H. Rowe and Son, Ltd.

MR. WALTER GRUNEBAUM has joined Acrow (Engineers), Ltd., as an executive director.

OSMA PLASTICS, Ltd., announces that Mr. L. F. Bull has been appointed a director of the company.

MR. HERBERT FREDERICK BIBBY has been appointed general manager of Associated Electrical Industries Export, Ltd.

MILLARS MACHINERY COMPANY, Ltd., has announced the appointment of Mr. E. G. Wilkin as commercial manager.

MR. G. F. CULLUM has been appointed publicity manager and public relations officer to the Goodenough Engineering Group.

FERRO ENAMELS, Ltd., announces that Mr. C. Vickers, A.M.I.E.E., A.M.I.Mech.E., has been appointed general sales manager.

MR. K. A. ROBINSON has been appointed to the board of a Lancashire Dynamo Electronic Products, a company in the Metal Industries Group

MR. C. T. ROBERTS, M.I.Mech.E., M.I.Loco.E., has been appointed chief mechanical and electrical engineer, Scottish Region, British Railways.

ABELSON AND CO. (ENGINEERS), Ltd., announces that Mr. C. B. Maxwell has been appointed director with particular responsibility for work service, spares and after sales service.

MR. RALPH W. BECK has been appointed executive vice-president of Molins Machine Company Incorporated, Richmond, Virginia, American subsidiary of Molins Machine Company, Ltd.

MR. PETER JARDINE has been appointed managing director of J. G. Statter and Co. and Minerva Mouldings of Amersham, both companies in the Metal Industries Group. He succeeds the late Lieut.-Colonel G. S. Marston.

BRITISH RAILWAYS, SCOTLAND, announces that Mr. C. W. Burnett, A.M.I.C.E., has been appointed district engineer, Irvine. Mr. D. H. Coombs, M.I.C.E., A.M.I.Mech.E., has been appointed district engineer, Glasgow North.

THE FIRTH CLEVELAND GROUP announces the appointment of Mr. Graham Cooke as group publicity director to head a new division which will co-ordinate and control advertising and public relations for the Group and all its members.

MR. R. H. PHILLIPS, managing director of Installation Equipment Group, The General Electric Company, Ltd. has been appointed a director of Pirelli-General Cable Works, Ltd. Sir Leslie Gamage, who recently retired as chairman of G.E.C. continues as chairman of Pirelli-General.

MR. G. B. LONGBOTTOM, A.M.I.Mech.E., has been appointed technical manager of The Hymatic Engineering Company, Ltd., in succession to the late Mr. H. R. Haerle. He has been succeeded as senior development engineer by Mr. J. S. Sivyer. Mr. D. M. E. Rawling has been appointed a project engineer.

THE RUBEROID COMPANY, Ltd., has announced the appointment of Dr. H. A. F. L. Kremer to the newly created position of chief development chemist. Mr. D. S. Symons, A.M.I.Mech.E., has joined the company as chief maintenance engineer at its Brimsdown, Enfield, factory, and Mr. C. W. High has been appointed electrical engineer at Brimsdown.

MR. A. CROCKETT, M.I.Prod.E., has been appointed to the board of directors of the Brooke Tool Manufacturing Company, Ltd. Mr. J. Lamb, chief accountant of the Brooke Tool Manufacturing Company, Ltd., has been appointed a director and chief accountant of the company's wholly-owned subsidiary, Brooke Tool Automation, Ltd.

RICHARD THOMAS AND BALDWINS, Ltd., has announced the following appointments to the engineering staff at the Spencer Works, now under construction at Llanwern, near Newport, Mon.; Mr. F. J. Feltoe, A.M.I.Mech.E., A.M.I.E.E., chief fuel and power engineer ; Mr. J. W. Oswald, A.M.I.E.E., chief electrical engineer, and Mr. S. Shillito, A.M.I.Min.E., manager, productivity engineering department.

TAYLOR WOODROW (BUILDING EXPORTS), Ltd., announces that Mr. Dick Onions has taken up residence in Ghana as the company's area representative and Mr. John Dix, A.M.I.Struct.E., has been appointed technical area representative to the firm's Teheran office. Mr. Onions takes the place of Mr. L. A. Farr, who has joined Taylor Woodrow (Ghana), Ltd.

THE ELECTRONIC ENGINEERING ASSOCIATION states that the new Council has elected as chairman Dr. D. N. Truscott, General Electric Company, Ltd., in succession to Mr. L. T. Hinton, Standard Telephones and Cables, Ltd. Mr. W. D. H. Gregson, Ferranti, Ltd., was elected vice-chairman in succession to Mr. R. R. C. Rankin, Mullard Equipment, Ltd.

JOHNSON AND PHILLIPS, Ltd. has made new appointments in its home sales organisation. Mr. J. C. Robertson, M.I.E.E., previously London branch manager, has been appointed sales manager (home) and will be assisted by Mr. C. W. Cawte, A.M.I.E.E., who continues as sales manager (cables) and by Mr. R. L. Stanley, A.M.I.E.E., who becomes sales manager (plant). Mr. B. E. Leeson having reached the company's normal retiring age has, at his own request, been relieved of his sales management duties but will continue in a senior sales capacity particularly relating to the sale of switchgear in certain areas. Mr. R. A. Jones, A.M.I.E.E., has succeeded Mr. Robertson as London branch manager.

BAKER PERKINS, Ltd., announces that Mr. R. H. Wilkins, a joint managing director, has been appointed managing director of Rose Brothers (Gainsborough), Ltd. He will remain a member of the board of management of Baker Perkins, Ltd., and will divide his time between the two companies. Mr. A. I. Baker, chairman of Baker Perkins, Ltd., Mr. N. Mountain, director, and Mr. W. A. B. Brown, deputy managing director of the Forgrove Machinery Company, Ltd., have also joined Rose Brothers board. It was announced in January that Baker Perkins, Ltd., which has a strong interest in the wrapping and packaging machinery field through its wholly-owned subsidiary, the Forgrove Machinery Company, Ltd., has negotiated a merger with Rose Brothers (Gainsborough), Ltd., designers and manufacturers of an extensive range of machines in the same field. Mr. H. S. Ridley who will continue as chairman of Rose Brothers, has joined the board of the Forgrove Machinery Company.

Business Announcements

MAGNETIC DEVICES, Ltd., Newmarket, Suffolk, states that its telephone number is now Newmarket 3451 (ten lines).

MIRRLEES, BICKERTON AND DAY, Ltd., announces the opening of a new marine service depot at 6, Bell Street, Quay Side, North Shields, Northumberland (telephone North Shields 538).

PRITCHETT & GOLD and E. P. S. COMPANY, Ltd., has transferred its Newcastle depot to 20, Bankwell Lane, Off High Level Bridge Approach, Gateshead-on-Tyne, 8, (telephone Gateshead 70034).

HEADLAND GAUGES, Ltd., 45-46, Lower Marsh, London, S.E.1, has been appointed sole agent in Great Britain for the profile projectors and electro-mechanical computators made by Microtecnica of Torino, Italy.

THE MOND NICKEL COMPANY, Ltd., Thames House, Millbank, London, S.W.1., an affiliate of The International Nickel Company of Canada, Ltd., has changed its name to The International Nickel Company (Mond) Ltd.

AMBUCO, Ltd., Standbrook House, 2/5, Old Bond Street, London, W.1, has opened an office at 158, Bath Street, Glasgow, C.2. It has appointed Dron and Dickinson, Ltd., of that address to act as its representative in Scotland.

WHITE AND RICHES, Ltd., 46, Kingsway, London, W.C.2, announces that it has acquired a 40,000 square feet factory at North Lane, Aldershot, Hants., together with an existing business formerly owned by A. R. Wade, Ltd., specialists in electric furnaces.

ELLIOTT-AUTOMATION, Ltd., and LITTON INDUSTRIES INC., of Beverly Hills, California, announce the successful conclusion of negotiations for co-operation in the microwave valve field. A new £400,000 company, Elliott-Litton, Ltd., Manor Way, Boreham Wood, Herts., is (subject to the usual consents being granted) to be formed to assume responsibility for the principal British and Commonwealth interests of the electron tube division of Litton Industries and the microwave valve business of Elliott Brothers (London) Ltd., a member of the Elliott-Automation Group.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., Imperial Chemical House, Millbank, London, S.W.1, is erecting a new polyvinyl chloride plant at its Hillhouse Works, near Blackpool. This will raise its manufacturing capacity of p.v.c. from the present figure of 70,000 to 80,000 tons a year to 115,000 tons a year by the beginning of 1963.

THE BRITISH CENTRAL ELECTRICAL COMPANY, Ltd., Briticent House, 6 and 8, Rosebery Avenue, London, E.C.1, has been appointed sole southern distributor for the YEW insulation tester. Direct readings of insulation resistance are provided by the YEW model L-5 portable insulation tester. The instrument is available with voltage and resistance ratings of 500V, 1000 megohms or 1000V, 2000 megohms.

LIEUT-COLONEL R. C. T. TANGYE, chairman of the board of directors of Tangyes, Ltd., is leaving England on March 12 for a round-the-world tour lasting five weeks. It is his intention first to visit Tangyes of Canada, Ltd., Montreal. He will leave Canada on March 16 for Fiji and thence to New Zealand. On his homeward journey he will visit Australia, Singapore, Thailand, the Philippines and Hong Kong.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., Imperial Chemical House, Millbank, London, S.W.1, heavy organic chemicals division, is to increase production of alkylamines at Billingham, Co. Durham. At present there are two plants for making mono-, di-, and tri-methylamines, and one plant for mono-, di-, and tri-ethylamines, with a combined capacity of between 2000 and 3000 tons per year. A completely new methylamines plant will be built with a capacity more than five times that of the existing unit, which began production in 1952 and which will now be superseded. The new plant, which is due for completion in 1963, will be one of the largest in the world and will use the most advanced manufacturing techniques. I.C.I. is also increasing the capacity of the ethylamines plant to well over double the present figure. These extensions should be completed by the end of 1961.

Contracts

DAVID BROWN INDUSTRIES, Ltd., has received an order valued at more than £110,000 from the Dominion Engineering Company of Canada for two large gear hobbing machines.

ROBERT MCGREGOR AND SONS, Ltd., has received a contract valued at £205,205 for improving the Liverpool-Preston-Leeds Trunk Road, A.59, for a distance of 1¼ miles from the Lancashire boundary to North-East of Sawley Brow, Yorkshire. The scheme has been designed and will be supervised by West Riding County Council (County Engineer and Surveyor : Col. S. Maynard Lovell).

THE BRITISH OXYGEN COMPANY, Ltd., is putting in hand a third tonnage oxygen plant at the new Spencer Steelworks of Richard Thomas and Baldwins, Ltd. This plant, of 200 tons a day capacity, will bring the total daily output of high-purity oxygen at Spencer Steelworks up to 600 tons, as two 200-ton plants are already being built there. All three plants are being constructed, and will be operated by B.O.C. The first two are scheduled to begin operation by the end of this year, and the third will be ready early in 1963.

PETTERS, Ltd., has received an order from Preco, Inc., Los Angeles, for 500 P.C.1 single-cylinder, 5b.h.p. diesel engines to power alternators for the " Cargotemp " cooling system on refrigerator wagons operating on U.S.A. railways. Previous practice has been to take power for the fans from axle-driven alternators, but the installation of a self-contained diesel-alternator set under the wagon will enable the fans to run at constant speed, and increase payload by raising the air circulation and halving the amount of ice which has to be carried. The initial users of the system are the Pacific Fruit Express Company of San Francisco.

THE ROYAL SWEDISH AIR BOARD has placed a further contract to the value of over 25,000,000 Swedish Crowns (£1,700,000) with Marconi's Wireless Telegraph Company, Ltd., for the supply of secret electronic equipment for its air defence system. This follows substantial orders placed in 1959. At the centre of the Marconi system is a very high speed computer which solves a large number of interception problems simultaneously and enables the defence weapons—fighters, guided missiles and other defensive devices—to be brought into action at precisely the right instant. Black and white television and colour projection together with automatic information-dissemination techniques also play a part in the overall system. Approximately 500,000 transistors and diodes and 15,000 valves are incorporated in the equipment.

Aluminium Construction in South Africa

BY OUR SOUTH AFRICAN CORRESPONDENT

Boeing "707" Aircraft Hangar

THE aircraft hangar built for the South African Railways and Harbours to house their Boeing "707" aircraft at Jan Smuts Airport, near Johannesburg, is an imposing structure, a fair portion of which is of aluminium construction. The material was supplied by the Aluminium Company of South Africa (Acosa), now Alcon Aluminium of South Africa, Ltd. More than 80,000 square feet of Acosa's "Longspan" aluminium alloy building sheet, weighing only 29 tons, have been used.

The hangar has a free floor area of almost 1½ acres, measuring 336ft by 177ft and can accommodate two Boeing "707" jet airliners side by side. An inside view of the hangar is shown in Fig. 1. The construction of the hangar is such that it will be possible to double its size sometime in the future by dismantling the present temporary gable and re-erecting it to form a permanent gable wall.

The main girder has a clear span of 332ft 6 in between the centre lines of the supporting columns and a depth of 30ft, roof trusses are designed to span 117ft between the rear wall columns and the main girder with the 54ft long front portion as a cantilever terminating above the doors. The total weight of the structural steelwork for the hangar, excluding hangar doors, but including gutters and downpipes, is approximately 600 tons and is designed to stand a wind load based on a wind velocity of 80 m.p.h. and a vertical superimposed load of 10 lb per square foot.

The South African Railways and Harbours specified 20 S.W.G. "Longspan" aluminium alloy building sheet for the roof and were no doubt influenced in their choice of material by the fact that "Longspan" sheets' asymmetrical profile allows wide purlin spacing and provides rapid water shedding. The pitch of the roof is 7 deg. in front of the main girder and only 3 deg. behind it. Additional advantages of the light metal sheet are, of course, its ability to reflect radiant heat, to resist hail damage, and its light weight.

Purlins are spaced at 9ft centres, and 10ft long sheets are laid with a 1ft end lap and a 1ft corrugation side lap. Fixing is by means of special purpose-made fasteners which slide over the top flange of the purlin, and aluminium seam bolts which are used with diamond bituminous and "Neoprene" washers respectively. All side ends and laps on the roof are sealed by means of bitumastic compound which was compressed between the roofing sheets when seam bolts were tightened. The roof cladding behind the main girder was commenced when three bays of steelwork had been erected, and progressed at a satisfactory rate behind the erection of the remaining steelwork. Twenty-two gauge "Longspan" was used for siding.

The majority of the flashings were preformed in "Acosa's" 185 S.W.G. flat sheet. Acosa's "Softal"—aluminium coiled sheet in "dead-soft" condition—is used to weatherproof the two glazing slopes which are arranged in sloping tiers covering the full width of the building, and which extend to the ridge of the roof. All steelwork in contact with aluminium is painted with one coat of zinc chromote primer and two coats of bitumastic aluminium paint to prevent any possibility of bimetallic corrosion.

Other architectural features in aluminium include ninety-seven top hung aluminium alloy ventilator windows and more than 13,000 lined feet of extruded aluminium alloy astragals.

Fig. 2—Purlins supported by aluminium alloy columns for reservoir roof

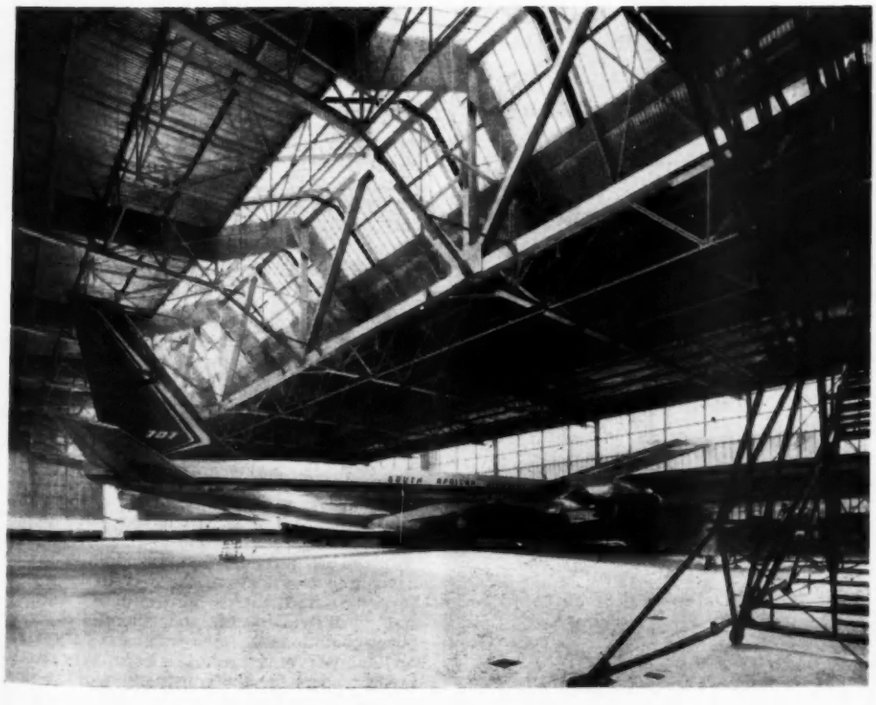


Fig. 1—Inside view of Boeing "707" aircraft hangar

Reservoir Roof

South Africa's first large aluminium alloy reservoir roof has just been completed in Pietermaritzburg by the City Engineer's Department. The 12,160 square feet, 20 S.W.G. "Acosa Longspan" aluminium alloy building sheet roof weighs only 5½ tons and is supported on extruded aluminium alloy purlins fixed to tubular 1·$^{9}/_{32}$ in. o.d. (0·176in wall thickness), 51 S.W.P. alloy columns set vertically into concrete bases on the reservoir floor (see Fig. 2). These columns are bitumen-dipped as they will, of course, be entirely under water when the reservoir is full, and are braced together with extruded ¼in diameter B.51 S.W. aluminium alloy stay rods. Extruded 17ft lengths of 6in by 3in B.51 S.W.P. channels are bolted to the top of each column to form the purlins which are spaced at 9ft.

The "Longspan" sheet is laid in 10ft lengths with a 1ft end lap and a one corrugation side lap, and is fixed to the purlins by means of aluminium alloy angle bolts through the ridge at every alternate corrugation (see Fig. 3). Side and end laps are fixed with aluminium alloy seam bolts used with "Neoprene" waterproofing washers. Adequate waterproofing was further assured by the application of a continuous bead of sealing compound to the interface of the end laps. Weather tightness is essential to exclude foreign matter from the reservoir.

The fixing of purlins to the reservoir walls allows for thermal expansion and contraction of both sheets and purlins. Special angle bolts which are grouted into the wall at every second corrugation fix the building sheet neatly to the wall. The contact faces of the "Longspan" and wall were coated with bituminous paint before the beam filling was applied.

Acosa aluminium is suited for the construction of reservoir roofs by virtue of its good corrosion resistance and good reflectivity. It is said to reflect more than 99 per cent of the radiant heat falling on it and therefore cuts evaporation to a minimum. In addition it is expected to last for many years with little or no maintenance.

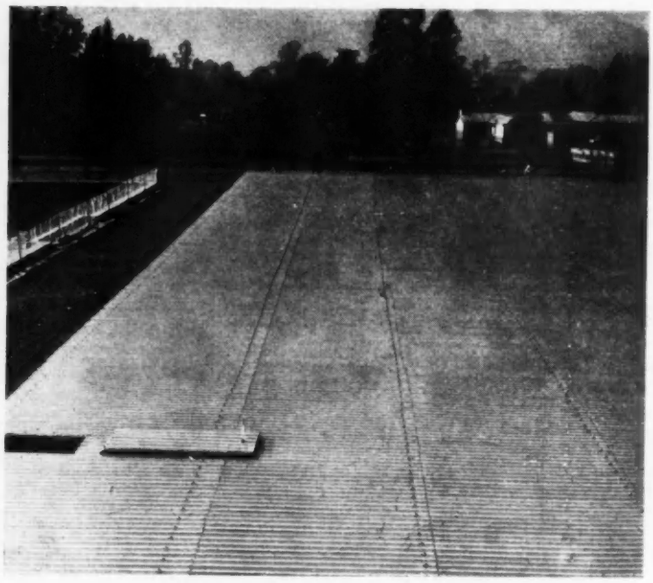


Fig. 3—"Longspan" sheet in position on reservoir roof

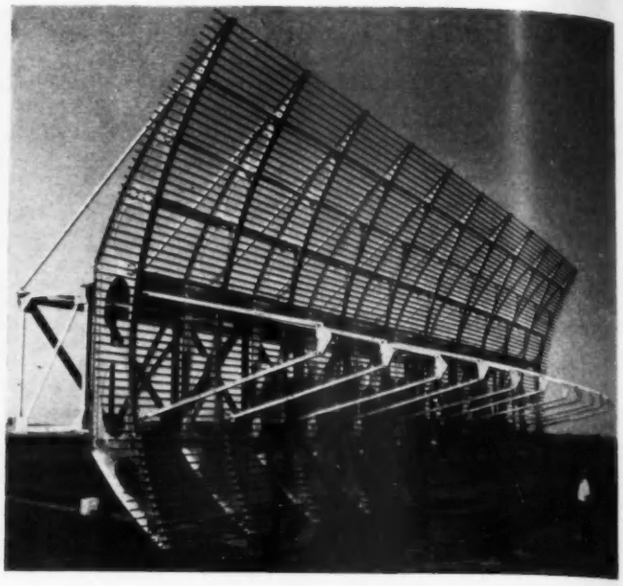


Fig. 4—Radar unit

Radar Unit

The South African Air Force's new radar unit at Prenaar's River in the Transvaal is capable of tracking aircraft 200 miles away.

The radar antenna is fabricated from "Acosa" M.57S. "half-hard" ¼ in aluminium alloy plate and B.51 S.W.P. extruded sections and tubing and is approximately 60ft long by 20ft high. Each of the eleven main vertical frames is made up of parts cut from plate and welded together. A.56S. aluminium alloy rivets are used to fix the aluminium alloy angles to the main frames, and horizontal tubular members are, in turn, fixed to these angles with aluminium alloy U-bolts. The supporting structure at the back is fabricated in steel and the unit is mounted on a brick base that houses a driving mechanism rotating the antenna through 360 deg.

The C.S.I.R. and telecommunications division of the General Post Office were responsible for its design and development.

Aluminium for Ship's Awnings

Oil tankers, often at sea for long periods in very hot climates, are renowned for their luxurious living quarters. Spacious cabins, many air-conditioned, are the order of the day, and no effort is spared to make the men who serve in these important ships as comfortable as possible. It is, therefore, a matter of no little interest that aluminium helps to do this on at least one large tanker, the 45,000-ton S.S. "Patria," which was fitted with a "Longspan" awning during a recent visit to Durban.

The awning comprises 20 S.W.G. "Longspan" building sheet fixed to an existing tubular steel framework with aluminium alloy fasteners, and covers the whole of the upper aft deck. A portion of the awning can be seen in Fig. 5.

The framework was formerly covered with canvas awnings which were not as cool as aluminium, nor do they have that metal's ability to remain in first-class condition in marine atmospheres. There can be no doubt that the corrosion resistance of aluminium coupled with excellent heat insulation values must have influenced its choice for the job.

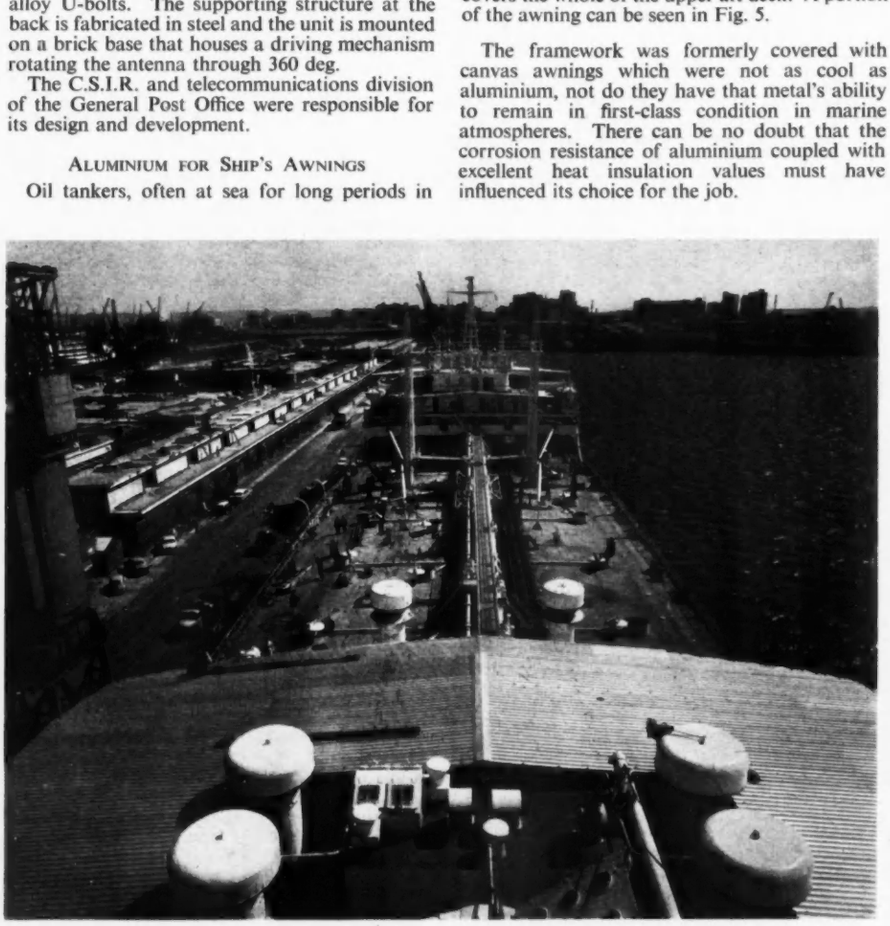


Fig. 5—Showing portion of ship's aluminium awning in foreground

Replacement of R.R.S. "Discovery II"

When not engaged on their normal surveying work of charting the sea coasts, H.M. surveying vessels are employed from time to time in taking ocean soundings for research into the shape and structure of the sea bed which it is believed will help scientists in their study of the earth's evolution. Two notable results of these investigations were the bringing to the surface of a 4ft "core" of the sea bottom from a depth of nearly 5 miles in the Puerto Rico Trench and the discovery of a new peak on the Mid-Atlantic Ridge—only 2200ft from the surface. But surveying vessels can neither spare the time nor are they adequately equipped for ocean-going research work and it is thus very satisfactory that plans are announced for the replacement of the R.R.S. "Discovery II" built in 1929 and owned by the National Oceanographic Council. The new ship is to have a length overall of 260ft, a breadth of 43ft and a displacement of 2800 tons. With diesel electric drive and a single screw, a service speed of 10 knots is envisaged over a range of 15,000 miles, and the ship is to be capable of working in the Arctic, Antarctic or tropical oceans. Fuel and stores will be ample for extended periods at sea.

Three thousand square feet of laboratory and ancillary scientific spaces are planned for marine physics, biology, chemistry, geophysics and geology. A low-temperature laboratory is to be provided for the biological work, and a platform on the foremast will house special meteorological instruments. There will be accommodation for twenty-one scientists and a crew of about forty. Special features will include a bow propeller for providing sideways thrust, an underwater periscope, an open well for underwater instruments through the ship forward of the fuel tanks, and two deck cranes capable of being used at sea. Self-supporting masts and cantilever upper decks will ensure that neither rigging nor side stanchions interfere with handling awkward overside scientific equipment. Scientific deck machinery is to consist of separate trawling and coring winches, a number of small oceanographical winches and a bathythermograph winch. Space is to be provided for a "package" laboratory, in which instruments can be assembled and tested at a shore base and the whole then transferred to the ship and connected to the appropriate services. Up-to-date navigational aids will be installed and, in addition to the navigating chart room, there is to be a large survey chart room for the use of the scientific staff. All living spaces and laboratories are to be air-conditioned. A maximum auxiliary power of 1200kW is envisaged. It is hoped very soon to invite tenders for the construction of the ship, and that she will be ready for service in the early summer of 1962.

CONTINENTAL AFFAIRS

by Our Continental Editor

Leipzig Spring Fair

No. I

A TOTAL of 9000 exhibitors from fifty-two countries are participating in the 1961 Leipzig Spring Fair which opened on March 5 and is to continue until March 14. The German Democratic Republic has 6000 exhibitors, western countries nearly 3000, including about 1000 from West Germany and West Berlin. Eastern countries are represented by over 200 foreign trade organisations.

The Fair is accommodated in twenty-two halls, seventeen pavilions and sixty-six exhibition buildings, as well as the open-air exhibition grounds; the whole area amounts to over 3,250,000 square feet. Products range over fifty-five industrial branches including both capital and consumer goods.

With 129,000 square feet of floor space, the largest foreign exhibitor is the Soviet Union, followed by Czechoslovakia (97,000 square feet), Poland (65,000 square feet plus 50 per cent) and Great Britain (64,500 square feet, plus 100 per cent.)

British participants this year number 200, compared with 152 in 1960. In the steel section alone, the number of exhibitors increased from thirty-five last year to fifty-one this year. Exhibitors included Colvilles of Glasgow, the only British maker of stainless steel clad plates; Armstrong Whitworth (Metal Industries), Ltd., Gateshead-on-Tyne, makers of rolls for rolling mills; and the English Steel Corporation, Ltd., Sheffield, and its subsidiaries. Tube Investments, Ltd., London, W.C.2, showed precision seamless and welded tubes from "hair thickness" up to 2ft diameter. Humphreys and Glasgow are showing a 1 : 30 scale model of an ethylene cracker now under construction at the "Walter Ulbricht" chemical works at Leuna. Another model is one of the Hammersmith Flyover which is to be seen on the stand of British Ropes, Ltd., Doncaster, which supplied the prestressing wires for the flyover. A fully transistorised sound level meter, the "1400E," suitable for measurements over the full audible range, is being shown by Dawe Instruments, Ltd., Brentford; this is a portable, battery-operated, direct reading instrument. The Solartron Electronic Group has on show a complete digital data recording system, comprising commutator unit, analogue-digital computer with display, and automatic printer with facilities for annunciation and alarm selection with both upper and lower limits. Two 15-ton tractors powered by 125 h.p. engines, one of them fitted with a side boom crane, are exhibited by Marshall Sons and Co., Gainsborough, Lincs. Among its range of valves fitted with automatic electric actuators, the Newman Hender Group of Companies have examples of the "Newman-Velan" design which are forged-steel, bonnetless globe valve, capable of being serviced, if necessary, without removal from the pipeline. They incorporate a screwed plug in the base through which the seat and disc can be relapped with the valve in true.

The prototype of an instrument which enables the surface roughness of a 1mm diameter steel ball to be measured and recorded in 0·02 micron is to be seen at the stand of the Taylor, Taylor and Hobson Division of Rank Precision Industries, Ltd. It is an attachment for use with the "Talysurf" Model III, and is for production testing. A stationary pick-up unit has its stylus mounted underneath a conical seating. The ball to be tested is placed in the seating where it is then rotated by a friction drive controlled from the "Talysurf" gearbox. In this way the surface speed is the same as that normally applied to the traverse of the conventional pick-up, so that both graphs and average readings can be obtained from a standard "Talysurf 3." The range of balls catered for is from 1mm to°25mm diameter. Graph readings are recorded with magnifications of up to ×50,000.

Also shown is the "Talysurf 105" which can measure the surface finish inside cylinders of 6mm diameter to a depth of 250mm.

K. and L. Steelfounders and Engineers, Letchworth, exhibited a Jones "KL 12-20" lorry-mounted crane, a 30-ton machine with a lifting capacity of 12 tons free on wheels and 20 tons with outrigger jacks extended. (On American ratings which are used in East Germany, the crane becomes a 25-ton capacity machine, 12½ tons free on wheels). It is mounted on a Foden six-wheel crane carrier powered by a Gardner "6LX" 150 b.h.p. oil engine with five-speed gearbox, and is capable of road speeds up to 20 m.p.h. Our illustration (Fig. 1) shows the crane fitted with a 90ft sectional lattice jib.

At the Hawker Siddeley Group stand, Bristol Siddeley, Coventry, showed a range of ball screws and ball splines which are being manufactured in co-operation with Beaver Precision Products Inc., Detroit. Ball screws are devices in which streams of steel balls re-circulate between nut and screw. Built in shaft lengths of from 5cm to 9m, and for loads of up to 370,000 lb to 825,000 lb static, the units are stated to be capable of functioning efficiently at temperatures between −55 deg. Cent. and over 400 deg. Cent. Lead accuracy is claimed to be

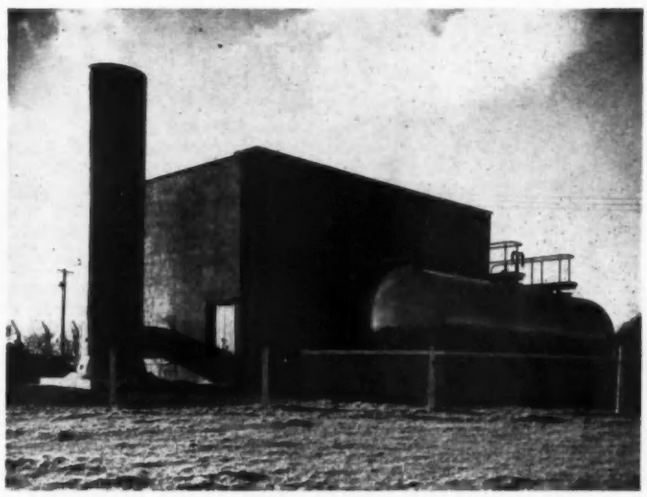


Fig. 2—"Proteus" 3 MW turbo-generator installed at Lynton, Devon. It is entirely automatic and under remote control from the electricity board's headquarters 100 miles away. — Bristol Siddeley

Fig. 1—Jones "KL12-20" lorry-mounted crane, fitted with 90ft sectional lattice jib.—K. & L. Steelfounders and Engineers

Fig. 3—Spun pressure vessel head with an inside diameter of 12ft 6in, dished and flanged from 1¾in thick stainless steel "Colclad" plate.—G. A. Harvey and Co. (London), Ltd.

CONTINENTAL AFFAIRS *(continued)*

0·00002in per foot; conversion efficiency is stated to be over 90 per cent. Similar claims are made for ball splines which have been built for operating torques of up to 50,000 lb inch (200,000 lb inch) maximum static torque.

The same company showed models of its 3MW turbo generator based on the "Proteus" 4250 h.p. turboprop engine adapted for running on diesel fuel. Such plant is in operation at Lynton and Princetown, Devon, and a further set is to be installed this year at Porlock, Somerset Fig. 2). The sets are entirely automatic and are operated by telephone under remote control from Bristol, 100 miles away. Another version can run on natural gas with a heat rate of 15,300 B.Th.U. per kilowatt hour. It is claimed that a generating plant of this kind costs only one-third to one-half as much per kilowatt capacity as conventional stations. Designed for peak-sharing and standby generation, the gas turbine stations can deliver full power within two minutes of a cold start, while life between overhauls, under peak lopping conditions, is estimated on ten years. The installation includes two independent turbines, one for driving the compressor, the other driving the alternator. This permits each to run at its optimum speed under all conditions and facilitates starting, since only the compressor system has to be rotated by the starter. The alternator is rated at 3370kVA at 0·9 power factor, the generator at 11kV. A version suitable for mounting on a road transporter or flat railcar was also shown as a model.

A large spun pressure vessel head, dished and flanged from 1¾in thick stainless steel "Colclad" plate, is the main exhibit of G. A. Harvey and Co. (London), Ltd. The head, which weighs 6¼ tons, is of ellipsoidal shape with an inside diameter of 12ft 6in. Its machined edge has been etched to show the stainless steel corrosion-protecting surface to the thick carbon steel plate (Fig. 3). The head was formed on a "Rotarpress" machine, which is capable of forming and finishing heads up to 15ft in diameter and 4in in thickness.

(To be continued)

Ninth General Report of the High Authority

IN the preface to its Ninth and latest Annual Report the High Authority of the European Coal and Steel Community briefly outlines the emergency measures taken for the benefit of the Belgian coal market, the satisfactory results of the revision of a first Treaty article (Article 56), the financial policy of the High Authority, the unprecedented expansion in both production and investment in the European iron and steel industry, certain decisions concerning cartels and concentrations, the progress achieved in the rail-transport sectors by the institution of new rates for full trainloads of coal and steel in Germany, the settlement out of court of the A.T.I.C. dispute, and the successful organisation of the first major conference on the redevelopment of areas affected by pit closures.

In all these matters, the High Authority goes on, it is hard to imagine that such substantial results would have been achieved in anything like reasonable time had it not been for the existence of a body independent of the individual Governments and in a position to weigh up the different interests involved while at the same time never losing sight of the general interest of the Community as a whole.

Moreover, says the High Authority, if it had not itself enjoyed the financial independence it does, the various borrowing, lending and credit operations carried through could not possibly have been undertaken on such a scale.

Experience has shown, the High Authority continues, that pending the progressive extension of the operation of the Treaty of Rome, the E.C.S.C. Treaty is already enabling far-reaching action to be taken to deal with concrete economic and social problems. To consider its work as being of a purely technical nature would therefore be to misunderstand the very real political significance of the first European Community.

In support of this point the High Authority cites the matter of the co-ordination of energy policies. Here, it explains, since the interests of the consumer countries are sharply opposed to those of the producer countries, discussion would be difficult if it were not for the existence of European organisations independent of the Governments.

With regard to the European situation ten years after the Schuman Declaration of May 9, 1950, the High Authority notes that one of the main objectives of that historic proposal, *de facto* solidarity among the peoples of Europe, undoubtedly began to come into being at the very inception of the Common Market for coal and steel, and has steadily continued to establish itself throughout the ensuing years.

Taking the functions of the different Community institutions in this context, the High Authority concludes that the development in practice of their operation as provided for in the E.C.S.C. Treaty has been such that they may be confidently expected to continue working well in the future.

This being so, the High Authority feels it can safely emphasise that it welcomes the concept of a single executive for the three existing Communities: at the same time, it stresses that this must not involve any whittling-down, even on apparently minor points, of the contents of the E.C.S.C. Treaty, particularly with regard to the status of the Members of the High Authority and to its financial independence. Only if the projected merger is a pooling of everything that all three Communities are and stand for, says the High Authority, will the single executive be a really big step forward. The Report notes the increasing favour shown to the idea of a common and concerted commercial policy *vis-a-vis* third countries, and sketches the position regarding E.C.S.C.'s external relations (the Agreement of Association with the United Kingdom, the Greek problem, and relations with the other international organisations).

Co-ordinated Energy Policy.—In 1960, in consequence of an exceptionally rapid growth of industrial activity (approximately 12 per cent) and record levels of steel production, energy consumption rose by close on 7 per cent. Earlier forecasts for 1961 had suggested a growth of only 4·7 per cent in gross national product and 6·5 per cent in industrial production. Had this been so, the increase in energy consumption would have worked out at about 3 per cent.

An increase in overall energy requirements does not necessarily mean greater consumption of all the different sources of energy available. Thus in the primary-energy sector, the trends in the consumption of solid and of liquid and gaseous fuels differ fairly markedly, as may be seen from the following table.

The share of coal on the whole has therefore been shrinking fairly steadily for ten years at a rate of approximately 2 per cent a year, while petroleum products in liquid and gaseous form are moving into its place. In 1961, assuming that it will be a year of moderate industrial expansion, there is to be expected a falling-off in the general demand (in absolute figures) for coal, so that consumption will again be slightly below the level for the preceding year.

The share of oil in covering the increased demand for energy has been predominant: in 1960, for example, it represented almost 60 per cent. The advance of fuel oil has been particularly in evidence in Germany with an increase of nearly 33 per cent, in Italy with 28 per cent and in the Netherlands with close on 18 per cent. The Report adds in this connection that the fiscal measures introduced in the oil sector in some countries during 1960 cannot be expected to have an immediate effect in retarding this development.

Turning to secondary energy, the Report draws attention to the extremely high rate of growth—over 10 per cent—in the demand for electric current in 1960. A further increase of 7 per cent is probable in 1961, which would appear to confirm that in future rates of increase will be fairly regularly above the level which would produce a doubling of consumption every ten years.

Demand for gas rose by approximately 12 per cent in 1960, and is expected to increase by a further 6·5 per cent in 1961.

In general for some years past energy of various kinds has been plentiful, making for even keener competition, not only between one producer sector and another but also within individual sectors. In the oil sector alone, with total production amounting to approximately 1000 million tons in 1960, there is a surplus installed capacity of 200 million tons.

An analysis of the coal-mining industry regarding productivities, costs and revenues, shows that notwithstanding an increase in hourly wage rates, the simultaneous percentage increase in underground output brought the production-cost index in 1959 6 per cent down on the previous year.

The fall in the c.i.f. prices of crude oil and petroleum products, and particularly of fuel oil, accentuated the change in the price relation between the competing fuels. Although, calorie for calorie, the ratio stood for years at about 1 : 1, since the second half of 1959 it has been shifting quite definitely to the advantage of fuel oil in certain areas, particularly the Western Netherlands.

The Report examines the action taken by the different Governments, some of whom are shown to be aiming at containing the trend in the coal sector at the cost of pushing up the prices of the competing fuels, while others do as little as they can to interfere with the continuing decrease in the latter. Most of the Governments are, however, seeking to steam excessive competition, which would be liable to result in costly changes not in line with the long-term trend.

In an interim memorandum of March 19, 1960, the inter-Executive working party gave its views to the E.C.S.C. Council of Ministers and the European Parliament on "the general drift of a co-ordinated energy policy." This memorandum sets forth the basic alternatives open, and suggests certain procedures to enable the

TABLE

	In percentage					In '000,000 hard-coal equivalent		
	1950	1955	1959	1960	1961*	1950	1955	1959
Hard coal	71·7	62·8	54·1	52·4	50	210·3	253·7	235·5
Brown coal	9·4	7·9	7·6	7·1	6·9	24·5	31·7	33·1
Oil	12·8	20·7	27·8	29·5	32	37·6	83·5	121·0
Natural gas	0·3	1·4	2·4	2·8	2·9	1·0	5·5	10·6
Water power and terrestrial heat	6·8	7·2	8·1	8·2	8·2	19·9	29·2	34·9
Total	100	100	100	100	100	293·3	403·7	435·1

* Provisional figures.

national energy policies to be co-ordinated as speedily as possible. It suggests, to make the flow of energy supplies as economic as possible ; to set up a single Community market for sources of energy ; to achieve security of supplies no matter what the state of the market at any given moment and a dependable minimum volume of supplies for the Community.

In order to decide, if necessary, which of these steps is to be given preference, the memorandum suggests the institution of a " guide price." This would be calculated mainly in accordance with forecasts of energy trends and with the political decision whether or not community fuels should be allowed a margin of preference over imported fuels.

The memorandum was examined successively by the Council of Ministers, the European Parliament and the appropriate sub-committee of the Consultative Committee. Further details were requested as to the concept, function and method of introduction of the guide price. It was emphasised that the use of a guide price as an instrument of long-term policy would not obviate the need for other forms of action, in order to cope with immediate problems.

The working party took up this point forthwith, and in January laid a " crash programme " for the co-ordination of energy policies before the E.C.S.C. Council of Ministers which will examine the proposals on March 7.

This " crash programme " advocates harmonisation in the field of commercial policy *vis-a-vis* third countries, rules of competition, and fiscal and administrative regulations ; a consultation agreement, providing in particular for prior notification of the other member States respecting any fresh internal action by individual Governments ; and an agreement on safeguards to be adopted in the event of a sudden deterioration in the state of the coal market.

Market Policy for Coal.—In 1960 the coal market improved, but nevertheless it is considered necessary that the coal-mining industry should persevere with its adjustment to the changed conditions in the market. The Report also discusses in full the extent and implications of the coal crisis.

The High Authority's main objective is, as it has always been, to improve the competitive capacity of coal in relation to the other sources of energy. To do this, the coal-mining industry must carry out a drastic and accelerated process of adjustment, but in the meantime it is necessary that the effects of the crisis should be cushioned and conditions established for colliery concentrations and closures to be effected without involving intolerable economic and social hardship. This necessitates an effective policy on the re-adaptation (resettling, retraining, &c.) of the workers concerned, an aspect described elsewhere in the Report. Indeed in some instances whole areas will have to be redeveloped industrially.

Reconstruction operations are going on in the different coalfields : in Germany, eighteen pits, representing an aggregate annual capacity of 6,400,000 tons, will have been closed between July, 1958, and the end of 1961; in Belgium, 9,500,000 tons a year in all are to be forfeited under a schedule of closures running from 1959 to 1963 ; in France, the Centre/Midi coalfield is undergoing reorganisation and a five-year adjustment programme has been prepared.

Special Community action has had to be taken with regard to Belgium, namely the invocation of Article 37.

Belgian Government subsidies authorised for 1961 in respect of 3,300,000 tons of coal, representing the sum of B.fr. 400 million, were to be paid only on condition that the schedule of closures was duly implemented and that the subsidised collieries observed the prescribed production ceiling.

For Germany, the High Authority recommended that in 1961 the duty-free quota of third-country coal be increased to not less than 6,000,000 tons, duty on excess tonnages to remain at DM.20 per ton.

Payments to help finance the holding of accumulated stocks were continued in 1960 until the funds set aside for this purpose were exhausted. Close on 7,000,000 dollars were made available under this head ; 5,070,000 of these were in the form of repayable advances.

As regards the state of the coal market in 1960. total availabilities and total requirements more or less balanced, and the production loss due to short-time working was reduced to 5,800,000 tons, as against 12,300,000 tons in 1959. Imports from third countries dropped still further, from 19,200,000 tons to 17,800,000 tons.

Average output in the pits rose substantially, to 1961 kg at the end of 1960 as against 1819 kg at the end of 1959. The number of workers employed fell by 54,700, of whom 28,700 left the industry in Germany and 12,900 in Belgium. There was a tendency to make adjustments in certain schedule prices ; in Belgium, however, there were reductions in respect of all grades. Community production totalled 233,900,000 tons, which is 1,000,000 tons less than in 1959. Pithead stocks of hard coal dropped from 31,200,000 tons at the end of 1959 to 27,700,000 tons at the end of 1960. A further falling-off in demand is, however, expected, in spite of the active state of the economy generally. Any levelling-off in expansion, and of course still more a recession, would mean a decided worsening in the position of coal.

Production of coke-oven coke increased during 1960, from 70,200,000 tons to 73,900,000 tons. By the end of the year stocks had been reduced to 6,600,000 tons.

The State of the Steel Market.—Business continued buoyant and prices remained remarkably steady. The scrap gap amounted to no more than 2,000,000 tons. Pig-iron production stood at 54,300,000 tons, 95 per cent utilisation of capacity, with a striking increase in the production of basic Bessemer and steelmaking pig. Production of ore was, except in France, lower than had been forecast, at 95,800,000 tons extracted ; imports from third countries totalled 30,000,000 tons. Community crude-steel output reached the all-time record level of 72,800,000 tons.

The highest rate of increase in steel production was recorded by Italy, with 21·5 per cent, the Community average standing at 15·3 per cent. The share of the Community in world steel production remains above 20 per cent (20·7).

The proportion represented by oxygen-blown steels is increasing rapidly, at the expense of basic Bessemer. Production of fine and special steels now accounts for 8·1 per cent of the total, but the most notable increase is in that of flat products, owing to the rising demand for sheet (over 10,000,000 tons were produced in 1960). Trade within the Community continues to expand ; imports from third countries increased by 600,000 tons, while exports to them show a slight drop of 400,000 tons.

Prices in the Community remained steady, with the exception of a rise in France : French prices are, however, still the lowest in the Community.

Rheinisch-Westfälisches Elektrizitätswerk A.G.

The annual general meeting of Rheinisch-Westfälisches Elektrizitätswerk A.G. (RWE), the principal power company in the German Federal Republic, was recently held in Essen. In its reports covering 1959–60, the sixty-second year of business, the Board proposed an increase in the basic capital from DM.575 million to approximately DM.719 million by capitalisation of reserves and a further increase to DM.795 million by a new share issue.

The report notes an increase in electricity consumption in the Federal Republic during the year of 11·5 per cent as against 5·3 per cent in the preceding year. Industrial current consumption, equal to about 70 per cent of the total, increased by 11·9 per cent (3·4 per cent). This closely correlates with an increase in industrial production of 12 per cent, although current consumption per unit of output has tended to decrease, especially in the chemical and iron and steel industries which are leading consumers of electric energy. Other branches such as non-ferrous metals, mechanical engineering and the textile industry have shown increases in specific consumption. It is of interest that the increase in the consumption of current was substantially higher than that of the national income which amounted to 7·6 per cent (3·6 per cent). This growth of the national income was achieved despite the fact that—because of full employment—the number of workers increased only slightly by 2 per cent and the number of hours worked by only 1 per cent.

During 1959–60, RWE supplied 29,600GWh, including the output of Fortuna power station leased from the Rheinbraun lignite concern (formerly R.A.G.), but excluding the output of a 150MW set at Frimmersdorf power station belonging to VAW aluminium company, of Bonn. This is an increase of 17·2 per cent on the year, or 14·1 per cent if the Rheinbraun generation is deducted. The distribution of the output among the various consumers is shown in the following table.

TABLE — *RWE Deliveries of Electrical Energy 1959–60 (net)*

	Per cent
Industry :	
Chemical industries	22·9
Iron and steel	21·1
Basic materials	2·7
Minerals, glass, ceramics	2·1
Textiles and leather	1·2
Wood and paper	0·8
Foodstuffs	0·7
Communities retailing electricity	5·5
Outside supply companies	27·9
Export	3·2
Domestic users	5·3
Trades and commerce	2·8
Public utilities	1·1
Transport	1·2
Agriculture	1·0
Armed forces	0·5
Total	100·0

Deliveries to supply companies in Southern Germany which depend upon water power, and exports, increased by an all-time high of 39 per cent (compared with a decrease of 25 per cent the year before). This is explained by the drought conditions of 1959. If these groups—which are customarily subject to wide fluctuations—are excluded, the increase in power deliveries to all other customers was 10·6 per cent. Increases in domestic consumption, agriculture and trades together totalled 12 per cent, domestic consumption alone showing an increase of 15 per cent.

Among technical developments, the report refers to the Kahl 15MW experimental atomic power station (ownership : RWE 80 per cent, Bayernwerk 20 per cent) which after a construction period of 2¼ years first became critical on November 13, 1960, and is expected to be commissioned early this year. Detailed tenders for large-scale nuclear stations of 250MW to 300MW have been obtained and are being examined. The German Atomic Law which came into force on January 1, 1960, has so far proved an instrument difficult to handle in the various negotiations required in connection with nuclear projects, and the cost of insurance is considered high in relation to the meagre protection which is obtained. It is hoped that experience gained with the Kahl station will bring about an easing of the situation.

With regard to thermal power plant, this is based mainly on the lignite deposits in the Cologne basin. At the Frimmersdorf power station, the fifth stage (three additional 150MW sets) has nearly been completed. A similar sixth stage is scheduled for completion by the end of 1962 when the total installed capacity will be 1700MW. Of the old Frimmersdorf station which is gradually being closed down, there remains only a capacity of 75MW. Fortuna I–III and Weisweiler II (formerly " Zukunft ") have been leased from Rheinbraun and Braunkohlen-Industrie A.G. " Zukunft," respectively. Fortuna I–III now has a capacity of 1000MW (90MW). At Niederaussem near Berghem, a new power station " Fortuna IV " is under construction. The first two 150MW blocks have been commissioned ; when completed in 1963, the station will have a capacity of 900MW.

Studies of oil firing in power stations are being continued. With regard to water power, the report refers to progress at the part-owned pumped power station at Vianden (Société Electrique de l'Our) of which the first stage of 400MW is to come into service in the autumn of 1962. Two sets are ready at the Moselle power station at Trier, but it is stated cannot yet be put into service because of certain safety measures in the headwater area which have not yet been completed. The Moselle stations Lehmen and Detzem, now under construction, will probably be completed next winter.

THE AMERICAN SCENE

By Our American Editor

Progress of the Tennessee Valley Authority

No. I

DURING the fiscal year 1960 the steady progress in the overall activities of the T.V.A. was overshadowed in public interest and attention by a major change in the financial arrangements for the power system—the authorisation by the Congress in August, 1959, for the sale of electric power bonds on the public market to finance additions to the power system as necessary to meet future power requirements in the region. The preparation for the sale of bonds was a major activity during the year, involving a number of tasks new to a Federal resource development agency. Lines of communication were established with the private financial community in which the bonds are to be sold. Information needed by financial institutions and private investors was provided in a basic data book, setting forth the important facts about T.V.A. and particularly about its electric power operations. The members of the Board and key staff members appeared before an overflow meeting of the Municipal Forum of New York to present information and answer questions about bond financing plans. Appearances were made before other groups and additional meetings planned. Quarterly reports on power operations were initiated to keep the public abreast of the trends in power sales, revenues, and net income. At the close of the year, a general bond resolution embodying the general specifications covering the issuance of T.V.A. power bonds and the initial supplemental resolution relating to the first offering on the market were in preparation. A decision was made after the close of the fiscal year to sell 50,000,000 dollars of bonds, about half the amount needed for the 1961 fiscal year, on November 15, 1960.

Construction Progress

The major construction events during 1960 included the completion of 425MW of generating capacity for the power system and the initial operation of the new main lock at Wilson dam. At the end of the year about 3000MW of capacity was under construction and scheduled for completion by the autumn of 1963. The installed capacity of the generating system, including the Aluminum Company of America dams in the Tennessee Valley and the Army Engineer projects in the Cumberland basin, was 11,373,460kW at the end of the year, representing a net increase of 376,250kW over the previous year. T.V.A. completed and placed in operation a 275MW unit at the Gallatin steam power station and a 150MW unit at Johnsonville. The Corps of Engineers, U.S. Army, put two 12MW units on the line at its Cheatham dam on the Cumberland River. T.V.A. leased to the city of Memphis a 47,500kW steam power station it owns in that city, and three minor steam power stations which T.V.A. acquired years ago were retired from service; their combined capacity was 25,250kW. Construction continued on the 500MW generating unit at the Widows Creek steam power station, and on three hydro-electric units at the Wilson dam, each of 54,000kW capacity. At the same time, construction was started on new projects totalling 1,897,200kW of capacity. They included the large Paradise steam power station in Kentucky, which will have 1300MW of capacity in two initial units; a 500MW unit at the Colbert steam power station; and three additional generating units at the Wheeler dam. Another 500MW generator was ordered for installation as the eighth unit at the Widows Creek steam power station. The following table summarises power construction in the fiscal year 1960:

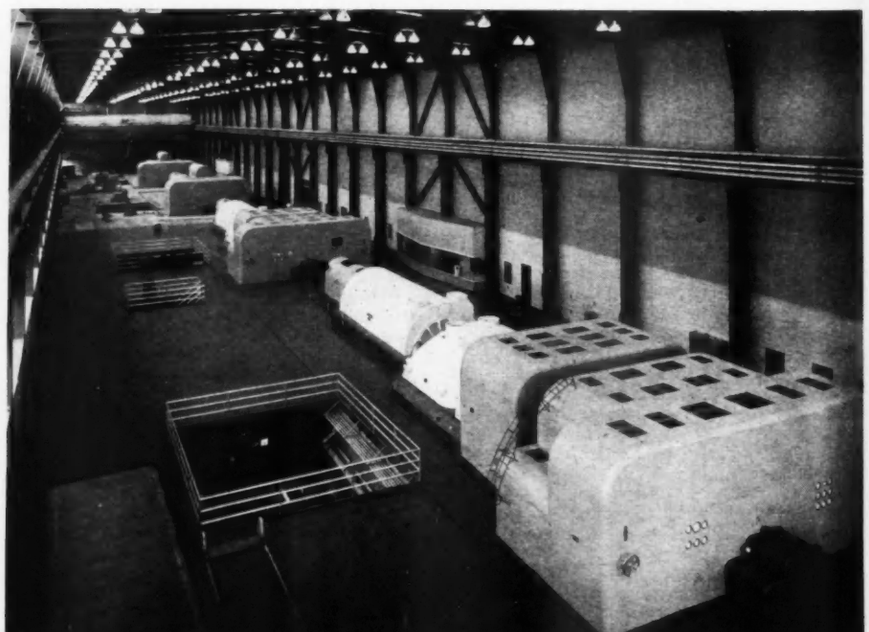
Project	Number of units	Nameplate capacity: Kilowatt per unit	Nameplate capacity: Total
Hydro:			
Wheeler	3	32,400	97,200
Wilson	3	54,000	162,000
Steam:			
Colbert	1	500,000	500,000
Gallatin	1	275,000	275,000
Johnsonville	1	150,000	150,000
Paradise	2	650,000	1,300,000
Widows Creek	2	500,000	1,000,000
Total	13		3,484,200
Placed in commercial operation	2		425,000
Still under construction	11		3,059,200

With demands for electric power showing a steady growth, the Authority must continually look ahead and plan for future generating and transmission capacity to meet the demands of consumers. The more than 3,000,000kW of new capacity under construction or ordered at the end of 1960 will bring the total installed capacity of the system to 14,516,660kW, sufficient, after making necessary allowances for operating reserves, to meet a probable demand of 13,200,000kW by the winter of 1963–64. To help meet further increases in demands, T.V.A. is planning a new station in the eastern part of its system. The first generating unit in that plant will have a record-breaking capacity of some 800MW.

River Locks.—The new Wilson dam lock, with its 100ft single lift, was dedicated and placed in operation on November 10, 1959. This eliminates a traffic bottleneck which has slowed down the growth of waterway use in recent years. The new Florence canal was completed shortly after the main lock was opened, and the old Lock No. 1 at the foot of the canal was abandoned. Immediately after traffic was routed through the new lock, work was started on the old tandem lock at the Wilson dam to make it available for auxiliary or emergency use. The work involves deepening the lower chamber of the lock and the approaches to it to conform to the level of the Florence canal, lowered 10ft by the elimination of Lock No. 1. The auxiliary lock became ready for operation in January, 1961.

The use of the new main lock and the Florence canal reduces locking time for large freight tows from four to five hours to an hour or less. Where towboats and barges formerly negotiated three lock chambers of small size, they now pass through only one—a single-lift lock having a chamber 600ft long and 110ft wide. It is capable of handling nine "jumbo" barges at a time, while the small lock chambers can accommodate only one.

With large-lock navigation provided from the mouth of the river through the Kentucky, Pickwick Landing and Wilson dams, preparations were made to begin construction early in the fiscal year 1961 of a 110ft by 600ft lock at the Wheeler dam, next upstream. Although the horizontal dimensions of the lock chamber will



New 275MW turbo-generator placed into operation recently at the Gallatin steam power station

be the same as at Wilson, the lift will be only about half as great—52 ft. The present lock is 60ft by 360ft and, since the improvement at Wilson, is the most serious bottleneck on the waterway. Within the next few years new large locks will also be required at the Guntersville and Hales Bar dams in order to provide the more modern facilities all the way to Chattanooga. In preparation for the construction of the Wheeler lock, scale model tests were used at the Norris Hydraulic Laboratory to devise an improved emptying and filling system. The tests indicated that the use of a large number of 8in pipe ports instead of the conventional larger openings would result both in lower cost and in less turbulence in the lock chamber. If, as expected, the new system works well in the Wheeler lock it will represent a substantial refinement in lock construction and will be used at future lock projects.

Steam-Electric Construction.—In November, 1959, T.V.A. began construction of a new steam-electric power station at Paradise, Kentucky, which initially will have two generating units of 650MW capacity each, making them the largest units so far ordered anywhere in the world. The plant is being designed for four units ultimately, and so could have a total generating capacity of 2600MW. The original plans for the plant contemplated generating units of 600MW capacity. However, designs worked out with the manufacturer resulted in an increase to a 650MW nameplate rating, with no increase in the cost.

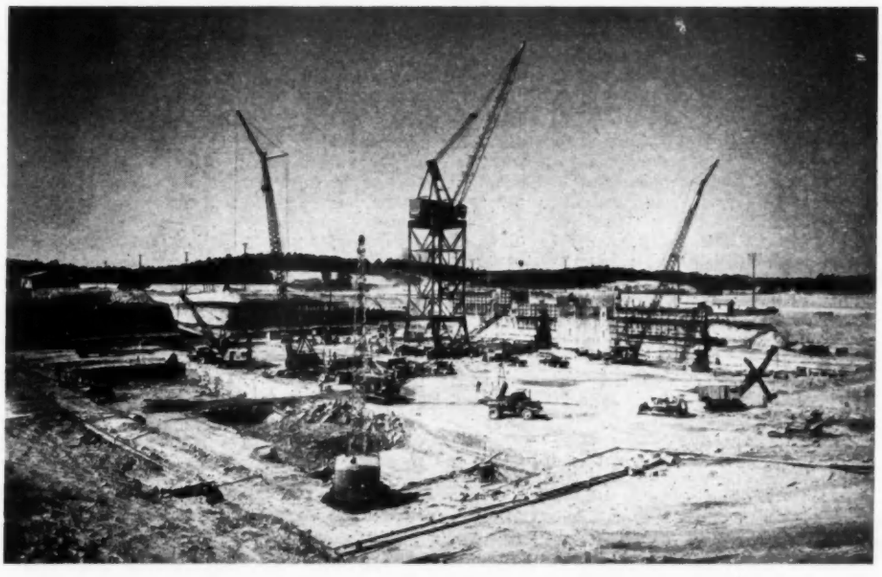
The site, in Muhlenberg County, Kentucky, on the Green River, is literally on top of extensive coalfields and thus has an unusually economical fuel supply. The Peabody Coal Company has contracted to deliver 65,000,000 tons of coal to the plant over a seventeen-year period, at a cost of 2·95 dollars per ton. Both at the plant and in the mining operations the coal will be handled by massive equipment. A pair of 2000-ton hoppers to accommodate 100-ton and 200-ton coal trucks will be provided. Two live storage areas will be able to stock 100,000 tons of coal in 100ft high piles. Four large hammer-mill crushers will be used instead of the numerous pulverisers feeding conventional boilers at other T.V.A. power stations. The system will be capable of handling 2000 tons of coal an hour. The coal supplier is designing strip-mining and transportation equipment of unprecedented size. The coal seams will be exposed by a power shovel capable of picking up 115 cubic yards of overburden in a single bite. The coal will be transported to the plant over specially built heavy-duty roads. Most of the coal will come from an area within 5 miles of the plant. The first generating unit at the power station is scheduled for operation in September, 1962, and the second in July, 1963.

The following paragraphs summarise the progress at the various steam power station construction projects during the fiscal year.

Widows Creek.—The construction of the 500MW unit proceeded on schedule, despite some difficulties, such as late deliveries of equipment and fabrication difficulties by manufacturers. It will be the largest unit ever put into operation in the United States. Added to the six 112MW units now in operation, the new unit will bring the total plant capacity to 1175MW. Widows Creek power station is on the Guntersville Lake in north-east Alabama.

Colbert.—Construction was commenced in January, 1960, on a 500MW unit at the Colbert steam power station, on the Pickwick Landing Reservoir in north-west Alabama. The unit is the second of such size in the T.V.A. system and was ordered from C. A. Parsons and Co. Rough excavation for the power station was completed by the end of the year. The present installation at Colbert consists of four 180MW units, the last of which was placed in operation in November, 1955. The new unit is scheduled for commercial operation in October, 1962, and will raise the Colbert installed capacity to 1220MW. The Parsons machine will be a cross-compound unit comprising two lines of turbines, each driving a hydrogen- and liquid-cooled generator at a speed of 3600 r.p.m., and operating with steam at a pressure of 2400 lb per square inch, 1050 deg. Fah. temperature, with reheating to 1000 deg. Fah. Each line of the machine will

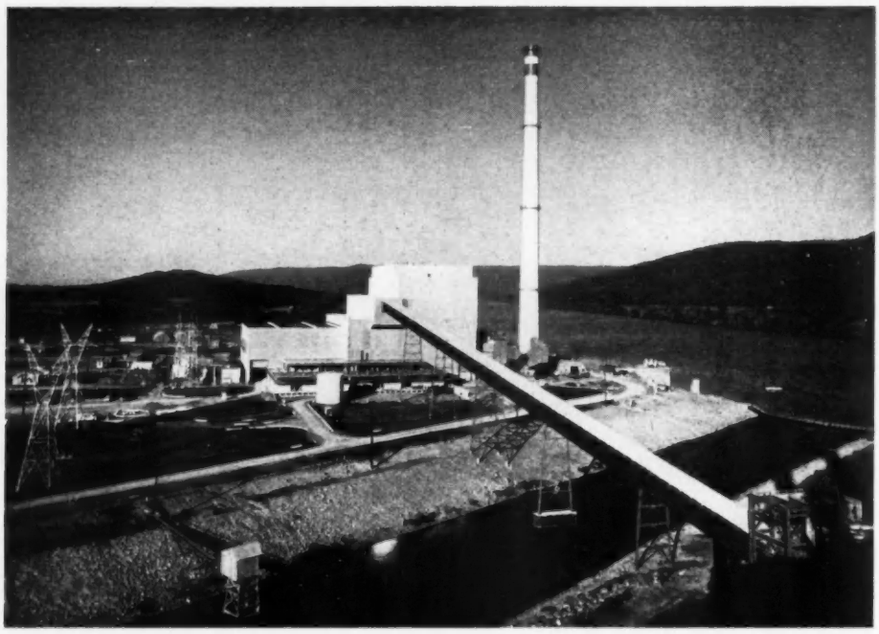
Dedication of the new Wilson dam lock, with 100ft single lift, in November, 1959



Construction progress at the site of the new Paradise steam power station in Kentucky

Scroll case installation at one of three 54MW turbines at the Wilson dam in Alabama

THE AMERICAN SCENE *(continued)*



500MW turbo-generator addition to the Widows Creek steam power station in Alabama

comprise three double-flow turbines. One line will consist of a high-pressure turbine and two low-pressure turbines, whilst the second will comprise an intermediate-pressure turbine and a further two low-pressure turbines. Because of the high steam conditions, a double casing design will be used on both the high-pressure and intermediate-pressure cylinders. All the turbine shafts will be rigidly coupled, including the couplings to the rotors of the generators. The generators themselves will have a rating of 250MW, 0·9 p.f., 24kV, generating current at a frequency of 60 c/s. The rotors will be direct-gas-cooled, operating in hydrogen at a pressure of 45 lb per square inch. The stator winding will be cooled by liquid circulating through hollow stator conductors.

Gallatin.—The fourth generating unit at the Gallatin steam power station, with a capacity of 275MW, was placed in commercial operation in August, 1959, bringing the installed capacity to 1050MW. Design is well along for facilities for the collection of dry fly ash. The fly ash is to be sold to a cement company and some is also to be used in concrete at the Paradise steam power station.

Johnsonville.—Commercial operation of a 150MW unit in August, 1959, brought the Johnsonville power station to its full complement of ten units, with a total generating capacity of 1275MW. Johnsonville, on the Kentucky Reservoir in west Tennessee, was the first steam power station to be built by T.V.A. after World War II. Construction was started in 1949, and six 112MW generating units were in operation by early 1953. The expansion of the plant through the installation of four 150MW units was begun in 1956 and completed early in the 1960 fiscal year with commercial operation of the tenth unit.

Hydro-Electric Construction.—Work progressed satisfactorily on two projects which will add 259,200kW of hydro-electric capacity at existing dams in the T.V.A. system, and plans were perfected for the construction of a new dam on the Clinch River, a major tributary of the Tennessee, to serve the purposes of navigation and power production.

At the Wilson dam three new 54MW generating units are being installed. They will bring the installed capacity at this dam to 598MW as compared with the present 436MW. As originally built by the U.S. Army Engineers, the Wilson power station contained eight generating units with a combined capacity of 184MW, with stalls for ten additional units. The last of these stalls was filled in 1950. The installation of the three new units involves the removal of the concrete from several bays of the spillway and considerable rock and concrete excavation below the dam. This has required carefully controlled blasting in order not to damage the dam or the power station. The blasts are monitored by a seismograph acquired for the purpose. By the end of the fiscal year all the rock excavation had been completed and one of the three penstocks had been placed and concreted in. The erection of the turbine has been started and the three units are scheduled for initial operation in August, October, and December, 1961.

At the Wheeler dam construction was started in February, 1960, on the installation of three new generating units. The new units will be of the same size as the original eight, 32,400kW, and will increase the total plant capacity from 259,200kW to 356,400kW. The new Wheeler units will be installed in an extension of the present power station and will replace the trashway and part of the non-overflow section of the dam.

Preparations were made to start the construction of a new dam at the Melton Hill site on the Clinch River as soon as funds were made available by the Congress in the appropriation bill for fiscal year 1961. The new project will be financed only in part by appropriated funds. The power station and generating equipment, and the proportion of the common facilities allocated to power, will be paid for from corporate funds. The dam is the first to be built by T.V.A. since the completion in 1954 of the Fort Patrick Henry dam on the South Fork of the Holston River, and will be situated on the Clinch River arm of Watts Bar Lake, about 23 miles upstream from the mouth and about 57 miles downstream from Norris dam.

The Melton Hill dam will be 80ft high and 1072ft long, built of concrete. The power station will have two 36MW generating units, adding 72MW to be installed capacity of the system. While the Melton Hill reservoir will have little storage of its own, it will make use of water releases from the tremendous storage of the Norris reservoir. The navigation lock at the dam will have a chamber 75ft wide and 400ft long, capable of handling four " jumbo " barges at a time. The lock will have a maximum lift of 60ft. The dam will extend the 11ft channel, suitable for barges loaded to 9ft draught, 38 miles upstream, past the Oak Ridge reservation of the Atomic Energy Commission and a few miles beyond the city of Clinton, Tennessee. The channel will tap an area of substantial coal and timber resources ; the markets for both are expanding due to the construction of steam-electric power stations and of paper and pulp manufacturing plants. Mines in the area also produce high grade stoker coal for which a market exists outside the valley as well as within it. The 44-mile long reservoir will have a shoreline of about 144 miles in an attractive setting for recreational development. The lake is close to two large population centres, Knoxville and Oak Ridge, Tennessee.

(To be concluded)

Construction work at the Colbert steam power station for the 500MW turbo-generator addition

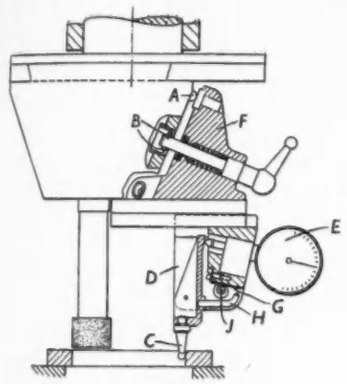
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on comple tion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

MACHINE TOOLS

861,294. January 3, 1958.—GAUGING-DEVICES FOR USE WITH MACHINE TOOLS, Hans Deckel, Waakirchner Strasse 7, Munich 25, Germany, and Friedrich Wilhelm Deckel, Lorettohöhe, Zug, Switzerland.

The invention relates to a feeler lever gauging device which is adapted to be mounted on a rotatable toolholder that can be traversed in relation to the principal axis of revolution of a machine tool. With this device a workpiece can be tested, for instance, for concentricity, without the tool having to be removed from the holder. The drawing shows the device fitted to a grinding head on a machine tool. The spindle which carries the grinding wheel performs a planetary motion and the casing in which the spindle is supported, can be displaced transversely in relation to the spindle axis along a slide. The casing carries three rounded dowels *A* to form a part of a three-point bearing. Approximately in the centre of these three centring dowels, there is a socket *B* having slots for a bayonet type fastening for the device. The gauging device consists of a contact finger *C* on a rocker which is pivotally suspended between two centre points in a forked holder *D*. The end of the rocker controls a dial gauge *E* of known construction. The holder is movable transversely on a slide and can be clamped in any position by two screws. The member *F* which carries the slide and hence the contact finger



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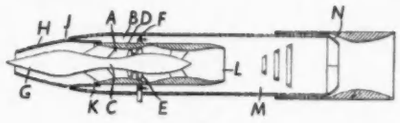
assembly has three arms, each fitted with a locating means for co-operation with the centring dowels *A*. A supplementary spring *G* is arranged, when released by rotation of an eccentric *J*, to act through a pin *H* on the contact finger. Whenever the spring is withdrawn, i.e. when in the position illustrated, the contact finger is solely under the influence of the return spring inside the dial gauge. Hence, an internal diameter can be sized. When the eccentric is turned into the position in which it permits the spring to act upon the contact finger through the pin, the spring will work in opposition to the return spring in the gauge and outside diameters of workpieces can then be tested. The gauging device that has been described is operated as follows. When the grinding operation is over, the working spindle is withdrawn axially and the grinding wheel thus lifted out of the bore. The contact finger assembly is then fixed to the casing by the bayonet fitting. By suitable adjustment of the slide the finger *C* can be moved into contact with the ground surface of the bore and the spindle is then slowly rotated. The contact finger slides over the surface of the bore and its deflections are registered on the dial of the gauge.—*February* 15, 1961.

POWER PLANT

861,101. September 2, 1958.—COMBINATION POWER PLANT FOR AN AIRCRAFT, United Aircraft Corporation, 400, Main Street, East Hartford 8, Connecticut, United States of America.

It is the object of this invention to provide for an aircraft a combination power plant, which includes a common inlet adaptable to either a turbine or a ramjet-type power plant. The combination power plant includes a central duct having a forwardly projecting cowl, a streamlined plug located in the central duct and co-operating with the cowl to define an opening, and means for relatively moving the plug and cowl to vary the area of opening. A turbine-type power plant is situated in the central duct downstream of the opening, with annular duct surrounding it, and a ramjet-type power plant is situated in the annular duct. The accompanying drawing shows a cross sectional illustration of a combination turbine and ramjet power plant with the turbine in the operative position. The combination power plant includes a central main duct *A* and an outer annular duct *B*. The duct *A* is formed by an inner body or plug *C* and the wall *D*. The outer duct is defined by the wall *D* and the surrounding casing. The duct *A* contains a turbine power



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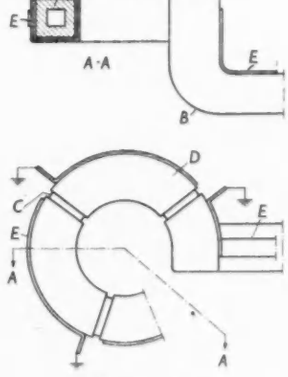
plant having a compressor section *E* which may be driven by any suitable turbine. The outer duct *B* may have fuel injected therein by means *F* so that the outer duct may operate as a ramjet. The central body *C* includes an upstream spike or conical portion *G* surrounded by a movable cowl *H*. In the position shown the cowl has its leading edge slightly aft of the leading edge of the spike. In addition, the point of maximum divergence *J* of the cowl is in juxtaposed relation with the leading edge lip of the outer wall, thereby closing off the inlet *K* to the duct *B*. In this position the usual subsonic inlet is receiving air from the airstream to supply the compressor of the turbine. As shown, the turbine has an exhaust *L* which emits gases into a common afterburner *M*. Thus, the afterburner can be used either for the turbine or for the ramjet. In either case a variable area nozzle *N* receives gases from the afterburner and forms a part of a convergent-divergent nozzle. When the cowl *H* is moved to its aft position, its leading edge is in juxtaposed relation with the point of maximum divergence of the conical section *G*. In this position a streamined central body is presented to the airstream and an internal compression inlet is provided for the outer annular ramjet operation. The various arrangements of the parts and some modifications are illustrated in the specification.—*February* 15, 1961.

ELECTRICAL ENGINEERING

861,276. December 1, 1959.—ELECTRIC VACUUM MELTING FURNACE.—Allmanna Svenska Elektriska Aktiebolaget, Västeras, Sweden.

The purpose of the present invention is to provide an improved electric vacuum melting furnace in which corona phenomena are considerably reduced. The upper drawing is an axial section through one turn of the coil of the furnace taken along the line *A*—*A* of the lower drawing, and an elevation of one connection lead. In the lower drawing is seen a plan



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of a part of the turn of the coil shown above it. Coil conductor *A* and the connection lead *B* which are assumed to be hollow for cooling purposes, are provided with electrical insulation *C* which is coated with a layer *D* of electrically conducting material. This layer is divided into a number of parts separated from each other. In the middle of the outer side of the turns of the coil a series of earthed conductors *E* are fixed. At this point any magnetic field existing is negligible or only very weak due to the presence of iron yokes outside the coil (not shown) and therefore the earthed conductors cannot be unduly heated. An earthed conductor *E* is also fixed to the layer of conducting material surrounding the connection lead *B*. It will be seen that each conductor makes electrical contact with its associated layer at least along a major part of the length of the layer. By the invention the efficacy of the corona protecting layers may be maintained even if the conductivity of the layers should be decreased or nullified by internal crevices. Although the conductors *E* are designated as earthed conductors, this term is to be construed as including conductors connected to potentials lying below the critical corona limit.—*February* 15, 1961.

861,628. February 3, 1958.—HIGH-FREQUENCY INDUCTION HEATING APPARATUS, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2. (*Inventor : Philip Watson Ainscow.*)

This invention relates to high frequency induction heating apparatus. Such apparatus usually comprises a generator which is adapted to supply power to a single work station or to a number of work stations simultaneously. A disadvantage of such apparatus, however, is that in order to remove a workpiece from the work station and to load another workpiece for heat-treatment it is necessary to stop the supply of power to the work station and so for a considerable proportion of its time the apparatus is inoperative. Accordingly the specification describes a high-frequency induction heating apparatus having two work stations which are arranged to be operative in turn so that an operator can assemble a workpiece at one station while another workpiece is being heat-treated at the other station. It comprises a transformer with two secondary windings, each associated with one work station, and means for moving the primary between two positions in which it is coupled to one or other of the secondaries. The primary winding may be arranged to be moved between the first and second positions coaxially with the secondary windings, and an electric motor may be provided for effecting the movement. In one construction, timing control apparatus is provided to effect the operation of the motor, and therefore movement of the primary winding. Since an inoperative work station is very loosely coupled to the primary winding, a mechanical device is arranged to short-circuit the terminals of the inoperative station in accordance with the position of the primary for although the induced e.m.f.' is not dangerous, a faint spark appears if the terminals are inadvertently short-circuited while the workpiece is being assembled and loaded, the psychological effect of which is undesirable from an operator's point of view.—*February* 22, 1960.

INSTRUMENTATION

861,457. October 21, 1957.—CIRCUIT ARRANGEMENTS FOR MEASURING ELECTRIC VOLTAGES, Philips Electrical Industries, Ltd., Spencer House, South Place, Finsbury, London, E.C.2.

The present invention relates to a device for measuring electric voltages in which the method of protection substantially does not affect the indication of the meter in its normal working range. The specification illustrates a circuit for measuring alternating voltages, the input terminals of which are bridged by a capacitor and rectifier in series. The rectifier forms part of a closed circuit which also includes a resistor and a milliammeter, the latter being the instrument which is to be protected. One terminal of the meter is connected to an input terminal through a glow discharge tube and a capacitor, from the junction of which connection is made through a variable resistance to the sliding contact of a potentiometer, the negative terminal of which is connected to the cathode of the rectifier and to the other terminal of the meter. The various voltages are so chosen that the glow discharge tube is cut off for normal values of the voltage to be measured. The deflection of the meter is then a measure of the voltage at the input terminals. When the voltage at these terminals becomes excessive the tube becomes conducting, resulting in an opposite flow of current through the meter. This current is interrupted at every negative half wave of the alternating voltage. The voltage at which the protection becomes active is adjustable by means of the potentiometer. The value of the reverse current which flows through the meter is adjustable by means of the variable resistor. The discharge tube is arranged so that its glow gives a visual indication of an excessive voltage at the input terminals.—*February* 22, 1961.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

AMERICAN ASSOCIATION OF COST ENGINEERS

To-day, March 10.—BRITISH GROUP : Institution of Civil Engineers, Great George Street, London, S.W.1, "Air Cooled Heat Exchangers," R. J. Anderson, 5.45 p.m.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Mon., March 13.—BOURNEMOUTH AND DISTRICT BRANCH : Grand Hotel, Firvale Road, Bournemouth, Tape Recording of A.S.E.E. Diploma Scheme Examination, and Lecturettes by members, 8 p.m.

Tues., March 14.—ALDERSHOT AND DISTRICTS BRANCH : Queen's Hotel, Lynchford Road, Farnborough, "Codes of Practice," S. J. Emerson, 8 p.m. ★ CHESTER AND DISTRICT BRANCH : Westminster Hotel, City Road, Chester, "Ball and Roller Bearings," T. S. Nisbet, 7.45 p.m. ★ EAST KENT BRANCH : Clarendon Hotel, Broadstairs, "Oil-fired Boilers and Associated Equipment," S. Austin, 8 p.m. ★ GLASGOW BRANCH : Kenilworth Hotel, Queen Street, Glasgow, "Electronics," R. H. Garner, 8 p.m. ★ PORTSMOUTH AND DISTRICT BRANCH : Committee Rooms, Ministry of Labour Offices, Lake Road, Portsmouth, "Decca Navigational System," 7.30 p.m. ★ SOUTH WALES BRANCH : Park Hotel, Park Place, Cardiff, "Control Centres for Modern Industries," 7.30 p.m. ★ YORK BRANCH : Royal Station Hotel, York, "Electrical Safety in Home and Factory," F. Clark, 7.30 p.m.

Wed., March 15.—NOTTINGHAM BRANCH : Nottingham Mechanics' Institution, Trinity Square, Nottingham, Open Forum, "Planning of Electrical Installations with Reference to Electrical Contractors and Architects," 7.30 p.m. ★ READING AND DISTRICTS BRANCH : Afternoon visit to the works of the Firestone Tyre and Rubber Company, Ltd. ★ WOLVERHAMPTON AND DISTRICT BRANCH : Chamber of Commerce, District Bank Chambers, Lichfield Street, Wolverhampton, "Summation Metering," M. L. Dunn, 7.45 p.m.

BRITISH INSTITUTE OF MANAGEMENT

Tues., March 14.—Connaught Rooms, London, W.C.2. One-day Conference on "New Technical Libraries in Industrial Organisations," 10 a.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., March 15.—SOUTH WESTERN SECTION : School of Management Studies, Unity Street, Bristol, "Airborne Servo System for Throttle Control," D. W. Thomasson, 7 p.m. ★ MERSEYSIDE SECTION : Adelphi Hotel, Liverpool, "Flight Simulators," D. J. Mauchel and R. Marvyn, 7 p.m.

Thurs., March 16.—ELECTRO-ACOUSTICS GROUP : London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Transistorised Tape Recorders," S. Welldon, 5.30 p.m.

CEMENT AND CONCRETE ASSOCIATION

Mon., March 20.—Mining and Technical College, Library Street, Wigan, "Prestressed Concrete," H. Kaylor, 7.30 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Thurs., March 16.—WESTERN REGION : Seabank Hotel, Porthcawl, Glam., "Instrumentation of the Boilerhouse," J. D. Rutherford, 10 a.m.

DIESEL ENGINEERS AND USERS ASSOCIATION

Thurs., March 16.—Institute of Marine Engineers, 76, Mark Lane, London, E. C.3, "Water Side Pitting of Diesel Cylinder Liners," H. H. Collins, 2.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., March 13.—SHEFFIELD CENTRE : Grand Hotel, Sheffield, "The Use of Coloured Light," H. Hewitt, 6.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Thurs., March 16.—BEDS. AND HERTS. SECTION : K. and L. Steelfounders and Engineers, Ltd., Letchworth, "Experiences in Making Moulds in a Mechanised Foundry," H. Pinchin, 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Mon., March 13.—WEST OF ENGLAND SECTION : Smith's Assembly Rooms, Bath, "General Developments in Ceramics for Marine Engineering," F. J. Aldred and N. W. Hinchliffe, 7.30 p.m.

Tues., March 14.—Memorial Building, 76, Mark Lane, London, E.C.3, "Materials for Advanced Steam Conditions and their Influence on Operation of Turbines and Boilers," H. E. C. Hims and S. H. Frederick, 5.30 p.m.

Thurs., March 16.—WEST MIDLANDS SECTION : Engineering Centre, Birmingham, "Heat Exchangers—Design Aspects to Avoid Corrosion," G. Page, 7 p.m.

INSTITUTE OF METAL FINISHING

To-day, March 10.—LONDON BRANCH : Constitutional Club, London, W.C.2, "Practical Plater's Night," 6 p.m.

INSTITUTE OF METALS

Mon., March 13.—SCOTTISH LOCAL SECTION : Institution of Engineers and Shipbuilders, Elmbank Crescent, Glasgow, C.2, "Metallurgy and Musical Instruments," W. H. Tait, and Annual General Meeting, 6.30 p.m.

Wed., March 15.—NORTH EAST METALLURGICAL SOCIETY : Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Properties of Metals at Very Low Temperatures," C. J. Adkins, 7.30 p.m.

Thurs., March 16.—BIRMINGHAM LOCAL SECTION : College of Technology, Gosta Green, Birmingham, "Choosing a Stainless Steel," H. T. Shirley, 6.30 p.m.

INSTITUTION OF MINING AND METALLURGY

Thurs., March 16.—Geological Society, Burlington House, Piccadilly, London, W.1, Discussion on the papers, "Application of Probability in the Assessment of Flotation Systems," D. F. Kelsall, and "Ion Exchange for Gold Recovery," J. Davison, 5 p.m.

INSTITUTE OF PETROLEUM

Wed., March 15.—61, New Cavendish Street, London, W.1., "Surface-Active Compounds in Lubricating Oils," A. Groszek and D. J. Palmer, 5.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

To-day, March 10.—SOUTH WALES CENTRE : South Wales Institute of Engineers, Park Place, Cardiff, "Servicing of Electrical Equipment," J. H. Stoneman, 7.15 p.m.

Mon., March 13.—MANCHESTER AND DISTRICT CENTRE : Stephenson Room, 3rd Floor, Engineers' Club, Albert Square, Manchester, "Air Suspension," V. E. Gough, 7.30 p.m.

Wed., March 15.—SOUTH EASTERN CENTRE : Wig and Gown Hotel, Maidstone, "The Future of Road Transport," A. Enticknap, 7.30 p.m.

Thurs., March 16.—METROPOLITAN AREA : Royal Society of Arts, John Adam Street, London, W.C.2, "Automatic Transmission Control Systems," R. B. Robinson, 6.30 p.m. ★ YORKSHIRE CENTRE : Great Northern Hotel, Wellington Street, Leeds, "The Future of Road Transport," A. Enticknap, 7.30 p.m.

INSTITUTE OF WELDING

Tues., March 14.—LIVERPOOL AND DISTRICT BRANCH : City of Liverpool College of Technology, Byron Street, Liverpool, 3, "Welding and the Draughtsman." H. B. Merriman, 7.15 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

To-day, March 10.—NORTH WESTERN BRANCH : Midland Hotel, Manchester, Annual General Meeting, 3.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., March 14.—Great George Street, Westminster, London, S.W.1, "The Design and Construction of Bombay Marine Oil Terminal," Sir Bruce White, C. R. White, A. H. Beckett, and P. E. Golvala, 5.30 p.m.

Thurs., March 16.—TRAFFIC ENGINEERING STUDY GROUP : Great George Street, Westminster, London, S.W.1, Discussion on "Future Developments in Traffic Light Signals," introduced by F. V. Webster, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, March 10.—NORTH SCOTLAND SUB-CENTRE : Robert Gordon's Technical College, Aberdeen, "Generator/Motor Problems in Pumped-Storage Installations," J. H. Walker, 7.30 p.m.

Mon., March 13.—INFORMAL MEETING : Savoy Place, London, W.C.2, Discussion on "Town Planning and Electrical Requirements," opened by L. H. Welch, 5.30 p.m. ★ LONDON GRADUATE AND STUDENT SECTION—ARBORFIELD DISTRICT MEETING : Unit Cinema 3 (Tels.) Training Bn., R.E.M.E. Arborfield, Berks., "The Work of the B.B.C. with Particular Reference to Transmitters," R. W. Leslie, 7 p.m. ★ EAST ANGLIAN SUB-CENTRE : Technical College, Cambridge, Discussion on "The Broadening of University Engineering and Science Courses," opened by H. E. M. Barlow, 6.30 p.m. ★ NORTH-EASTERN CENTRE : Neville Hall, Newcastle-upon-Tyne, "A Basis for Short-Circuit Ratings for Paper-Insulated Cables up to 11kV," L. Gosland and R. G. Parr, and "Short-Circuit Ratings for Mains Cables," G. S. Buckingham, 6.30 p.m. ★ SCOTTISH ELECTRONICS AND MEASUREMENT GROUP : Royal College of Science and Technology, Glasgow, Discussion on "Digital Transducers," 6 p.m. ★ SOUTH MIDLAND SUPPLY AND UTILISATION GROUP : College of Advanced Technology, Gosta Green, Birmingham, "The Determination of the Electrical Characteristics of an Arc Furnace," J. Ravenscroft, 6 p.m. ★ WESTERN CENTRE : S. W. I. E., Cardiff, "Silicon Power Rectifiers," A. J. Blundell, A. E. Garside, R. G. Hibberd and I. Williams, 6 p.m.

Tues., March 14.—EDUCATION DISCUSSION CIRCLE : Savoy Place, London, W.C.2, Discussion on "New Routes into National Certificate and Technician Courses," opened by H. W. French, 6 p.m. ★ EAST MIDLAND CENTRE : College of Further Education, Greenclose Lane, Loughborough, Junior Members' Night, 6.30 p.m. ★ NORTH MIDLAND CENTRE : H.Q. Mess, School of Signals, Catterick Camp, "Developments in Lighting," F. A. Benson, 5.15 p.m. ★ NORTH MIDLAND CENTRE EDUCATION DISCUSSION CIRCLE : Electrical Engineering Dept., The University, Leeds, Discussion on "Refresher and Post-Graduate Courses for Electrical Engineers," opened by G. W. Carter, 6.30 p.m. ★ NORTH WESTERN CENTRE : Engineers' Club, Albert Square, Manchester, "The Place of Formal Study in the Post-Graduate Training of an Electrical Engineer," N. N. Hancock and P. L. Taylor, 6.15 p.m. ★ NORTHERN IRELAND CENTRE : Civil Engineering Department, David Keir Building, Queen's University, Stranmillis Road, Belfast, 9, "Some Engineering Aspects of the 'Canberra'," J. H. Crossey, 6.30 p.m. ★ SCOTTISH ELECTRONICS AND MEASUREMENT GROUP: Carlton Hotel, Edinburgh, Discussion on "Digital Transducers," 7 p.m. ★ SOUTHERN CENTRE : The University, Southampton, "Analogue to Digital Converter Techniques and their Applications," K. L. Smith, 6.30 p.m.

Wed., March 15.—SUPPLY SECTION : Savoy Place, London, W.C.2, Discussion on "Magneto—Hydrodynamic Generation of Electricity," opened by P. L. Davies, and D. J. Harris, 5.30 p.m. ★ LONDON GRADUATE AND STUDENT SECTION : Institution of Civil Engineers, Great George Street, London, S.W.1, Joint Meeting with the Graduates' Section of the Institutions of Civil and Mechanical Engineers, "Space Research," Prof. Sir Harrie Massey, 6.30 p.m. ★ LONDON GRADUATE AND STUDENT SECTION : Visit to Leo Computers, Ltd., Bayswater, 2.30 p.m. ★ NORTH-WESTERN ELECTRONICS AND COMMUNICATIONS GROUP : Engineers' Club, Albert Square, Manchester, "The Potentialities of Artificial Earth Satellites for Radiocommunication," W. J. Bray, 6.15 p.m. ★ NORTH LANCASHIRE SUB-CENTRE : N.W.E.B. Demonstration Theatre, Friargate, Preston, Second Hunter Memorial Lecture, "The Protection of Electrical Systems," H. G. Bell, 7.30 p.m. RUGBY SUB-CENTRE : College of Engineering Technology, Rugby, "The Determination of the Electrical Characteristics of an Arc Furnace," J. Ravenscroft, 6.30 p.m. ★ SOUTH-WESTERN SUB-CENTRE : Washington-Singer Laboratories, Exeter University, Prince Wales Road, Exeter, "The Shielding of Overhead Lines against Lightning," J. H. Gridley, 3 p.m.

Thurs., March 16.—UTILISATION SECTION : Savoy Place, London, W.C.2, "A Dynamic Model for Studying the Behaviour of the Overhead Equipment used in Electric Railway Traction," D. S. Farr, H. C. Hall, and A. L. Williams, 5.30 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Wed., March 15.—YORKSHIRE BRANCH : Midland Hotel, Bradford, Film Evening, 7.30 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE

Wed., March 15.—Caxton Hall, Westminster, London, S.W.1, "Automatic Level Control," C. G. Scolding, 6.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., March 14.—39, Elmbank Crescent, Glasgow, "The Helicopter and its Place in the Transport Field," E. Mensforth, 6.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

Fri., March 17.—NORTH EASTERN BRANCH : Department of Civil Engineering, King's College, Newcastle-upon-Tyne, Annual General Meeting and "Major Highways Programme for the Tyneside Area," G. F. Garnett and W. H. B. Cotton, 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, March 10.—EDUCATION GROUP : 1, Birdcage Walk, London, S.W.1, Discussion on "Teaching Thermodynamics," opened by D. B. Spalding, 6 p.m. ★ WESTERN GRADUATES' BRANCH : Swindon Engineering Society, 2, Emlyn Square, Swindon, "An Engineer's View of Bus Operation," P. J. Warhurst, 7.30 p.m.

Tues., March 14.—AUTOMOBILE DIVISION : 1, Birdcage Walk, Westminster, London, S.W.1, "Research into Brake Usage in Passenger Cars," and "A Test Schedule for Passenger-Car Brakes," A. E. Livsey, A. F. Prestidge, and D. F. Woor, 6 p.m. ★ MIDLAND BRANCH : College of Technology, Rugby, "The Design and Development of Machine Tools," C. A. Sparkes, 6.30 p.m. ★ NORTH-WESTERN BRANCH : Royal Ordnance Factory, Blackburn, "The Use of a Computer in Industry," A. J. Platt, 7.30 p.m. ★ NORTH-WESTERN GRADUATES' BRANCH : Engineers' Club, Albert Square, Manchester, Brains Trust, 7 p.m. ★ SOUTHERN GRADUATES' BRANCH : Grand Hotel, Bournemouth, "Marine Reactors," H. W. Bowker, 7.30 p.m.

Wed., March 15.—YORKSHIRE BRANCH : The University, St. George's Square, Sheffield, Annual General Meeting and Film Show, 6.30 p.m. ★ EAST MIDLANDS GRADUATES' SECTION : The Technical College, Eastfield Road, Peterborough, "Why Diesels Differ from Petrol Engines in Design and Development," N. M. F. Vulliamy, 7.15 p.m. ★ NORTH-EASTERN GRADUATES' BRANCH : Cleveland Institute, Middlesbrough, "Industrial Electric Fuses," J. A. Green, 6.30 p.m. ★ SOUTHERN GRADUATES' BRANCH : Visit to I.C.I. Paints Division, Slough, 2.30 p.m.

Thurs., March 16.—ORDINARY MEETING : Royal College of Science and Technology, Glasgow, "Design of Modern Boiler Feed Pumps," H. H. Anderson, 7.30 p.m. ★ EASTERN BRANCH : Gaumont Restaurant, The Parade, Northampton, Repetition of the Chairman's Address, "Machining Problems with Radioactive Materials," P. H. Stephenson, 7.30 p.m. ★ EAST MIDLANDS BRANCH : Technical College, Scunthorpe, "Cost Reduction in Heavy Engineering," J. E. Chadfield, 7.30 p.m. ★ MIDLAND BRANCH : James Watt Memorial Institute, Great Charles Street, Birmingham, Repetition of the Thomas Lowe Gray Lecture, "The Early Development of the Dracone Flexible Barge," W. R. Hawthorne, 5.15 p.m. ★ SOUTHERN BRANCH : King and Queen Hotel, Brighton, "Planned Maintenance," W. Jones, 7.30 p.m. ★ SOUTHERN BRANCH : County Hotel, Canterbury, "Vertical Take-Off," D. Keith-Lucas, 7.30 p.m. ★ YORKSHIRE GRADUATES' BRANCH : Hotel Metropole, Leeds, "Hydraulic Problems of Rotary Wing Aircraft," S. Halstead, 6.30 p.m.

INSTITUTION OF PLANT ENGINEERS

To-day, March 10.—BIRMINGHAM BRANCH : Imperial Hotel, Temple Street, Birmingham, Mobile Plant Discussion Group, 7.30 p.m.

Mon., March 13.—MERSEYSIDE AND NORTH WALES BRANCH : Exchange Hotel, Liverpool, Annual General Meeting, 7.15 p.m.

Tues., March 14.—MANCHESTER BRANCH : Engineers' Club, Albert Square, Manchester, Annual General Meeting, 7.15 p.m.

Wed., March 15.—KENT BRANCH : King's Head Hotel, High Street, Rochester, "The Use of Light in Industry," A. E. Fothergill, 7 p.m.

Thurs., March 16.—BLACKBURN BRANCH : Castle Hotel, Blackburn, Annual General Meeting, 7.30 p.m. ★ PETERBOROUGH BRANCH : White Lion Hotel, Church Street, Peterborough, Annual General Meeting, 7.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, March 10.—EASTERN REGION : Electric House, Ipswich, "The Status of the Production Engineer in any Sort of Economy," H. Burke, 7.30 p.m.

Tues., March 14.—BIRMINGHAM GRADUATE SECTION : James Watt Institute, Great Charles Street, Birmingham, Annual General Meeting and Chairman's Address, 6.30 p.m. ★ SCOTLAND REGION : Chamber of Commerce, 25, Charlotte Square, Edinburgh, "Activity Sampling," E. A. Tough, 7.30 p.m. ★ SOUTH-EASTERN REGION : Room 233, College of Technology, Luton, "Dynamic Testing of Machine Tools," S. A. Tobias, 7.30 p.m.

Wed., March 15.—MIDLANDS REGION : Midland Hotel, Birmingham, Annual General Meeting, followed by a Lecture, 6.30 p.m. ★ WOLVERHAMPTON GRADUATE SECTION : Works Visit to Austin Motor Company, Ltd., Longbridge, Birmingham, 10.15 a.m. ★ WOLVERHAMPTON GRADUATE SECTION : Wolverhampton and Staffs. College of Technology, Wulfrun Street, Wolverhampton, Annual General Meeting, and Film Show, 7 p.m. ★ NORTH MIDLANDS REGION : Conference Room, Peterscourt, Peterborough, Annual General Meeting, 7.30 p.m. ★ LIVERPOOL GRADUATE SECTION : Stork Hotel, Queen's Square, Liverpool, 1, Annual General Meeting and Film Show, 7 p.m. ★ SOUTH-EASTERN REGION : 10, Chesterfield Street, London, W.1, Annual General Meeting and Film Evening, 7.15 p.m. ★ SOUTH-EASTERN REGION : Hoffmann Manufacturing Company, Ltd., Hoffmann Social Centre, Chelmsford, Annual General Meeting, 7.30 p.m.

Thurs., March 16.—SOUTHERN REGION : New Basingstoke Technical College, Worting Road, Basingstoke, Annual General Meeting, and "Production Techniques in the Instrument and Telephone Industry," H. A. Richardson, 7.30 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Mon., March 13.—MANCHESTER SECTION : Technical College, Newton Heath, "Textiles in Rubber Products Other than Tyres," W. Lord, 6.45 p.m. ★ MERSEYSIDE SECTION : Exchange Hotel, Liverpool, "High Energy Radiation of Rubber and Rubber-Like Polymers," R. W. Pearson, 7.30 p.m. ★ MIDLAND SECTION : James Watt Memorial Institute, Great Charles Street, Birmingham, "The Theory of Vulcanisation," J. E. Stuckey, 5 p.m., and "New Instrumentation Techniques," 6.45 p.m.

Tues., March 14.—LONDON SECTION : Royal Society of Tropical Medicine and Hygiene, Manson House, 26, Portland Place, London, W.1, "The Union of Rubber and Plastics," 5.30 p.m. and "Light Microscopy of Black-Loaded Rubber," C. H. Leigh-Dugmore, and "Electron Microscopy of Black-Loaded Rubber," E. H. Andrews, 7 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, March 10.—SOUTHERN BRANCH : Engineering Lecture Theatre, The University, Southampton, "Timber Structures," H. Tottenham, 6.30 p.m.

Tues., March 14.—LANCASHIRE AND CHESHIRE BRANCH : College of Science and Technology, Manchester, "Railway Bridge Work in the Liverpool/Manchester Area," F. Turton, 6.30 p.m.

Wed., March 15.—YORKSHIRE BRANCH : Metropole Hotel, King Street, Leeds, "Water Excluding Structures," L. E. Creasy, and L. Scott White, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, March 10.—Pepys House, 14, Rochester Row, Westminster, S.W.1, "The Grand Contour Canal as a National Water Grid," J. F. Pownall, 7 p.m.

Wed., March 15.—SHEFFIELD AND DISTRICT SECTION : Royal Victoria Hotel, Sheffield, Visit of the President, and Presidential Address, "The Development Engineer in the Petroleum Industry, E. S. Sellers, 7.30 p.m.

Thurs., March 16.—NORTH-WESTERN SECTION : Engineers' Club, Albert Square, Manchester, Visit of the President, and Presidential Address, "The Development Engineer in the Petroleum Industry," E. S. Sellers, 7 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Fri., March 17.—Lecture Theatre, Mining Institute, Neville Hall, Newcastle-upon-Tyne, "Experiments on Compression of Double-Bottom Plating," T. Jaroszynski, 6.15 p.m.

REINFORCED CONCRETE ASSOCIATION

Wed., March 15.—Royal Aeronautical Society, Hamilton Place, London, W.1, Symposium on "Large Diameter Bored Piles," 5.30 p.m.

ROYAL AERONAUTICAL SOCIETY

Mon., March 13.—HISTORICAL GROUP : Lecture Theatre, 4, Hamilton Place, London, W.1, "The Evolution of Transport Aircraft," P. W. Brooks, 7 p.m.

Thurs., March 16.—ASTRONAUTICS AND GUIDED FLIGHT SECTION : Lecture Theatre, 4, Hamilton Place, London, W.1, All-day Symposium on "The Training of Guided Missiles Engineers."

ROYAL INSTITUTION OF GREAT BRITAIN

To-day, March 10.—21, Albemarle Street, London, W.1, "Energy," Ronald King, 9 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Thurs., March 16.—ROAD AND BUILDING MATERIALS GROUP : 14, Belgrave Square, London, S.W.1, "White-Line Road Markings and Light Coloured Road Surfaces," J. A. Reid, Barbara E. Sabey, and J. G. James, 6 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Wed., March 15.—DATA PROCESSING SECTION : Manson House, 26, Portland Place, London, W.1, "Initial Experience on the Use of a Digital Computer for Burst Slug Detection," J. L. W. Churchill, and R. S. Hopkins, and "Burst Slug Detection Data Display at Bradwell," J. O. Joss, 6.30 p.m.

SOUTH WALES INSTITUTE OF ENGINEERS

Thurs., March 16.—Park Place, Cardiff, "Recent Developments in the Production of Steel Castings in Engineering," D. H. Snelson, 6 p.m.

TELEVISION SOCIETY

To-day, March 10.—Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2, "Colour Television Camera Problems," I. J. P. James, 7 p.m.